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SYNOPTIC ANALYSIS CASE 2. 23 MARCH 1978 - 27 MARCH 1978, (U)

JAN 79 D CHIN, H D HAMILTON

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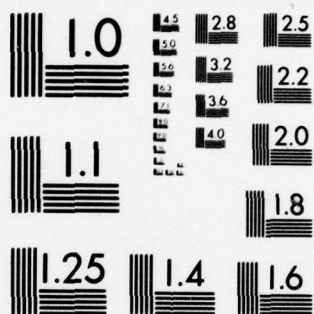
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SYNOPTIC ANALYSIS CASE 2
23 MARCH 1978 - 27 MARCH 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The synoptic scale weather conditions over the continental United States for the period 23-27 March 1978 are documented in support of the Large Scale Cloud Systems Program. Included in this report are the flight tracks of the research aircraft, a narrative description, and analyses of meteorological parameters from the surface to 300 mb. ★			

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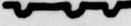
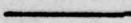
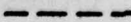
This report is one of a series of similar reports which document the synoptic scale meteorological conditions over the continental United States for a specified period. During each period, one or more flights were conducted by research aircraft in support of the Large Scale Cloud Systems Program. Each flight consists of several legs.

An overall synoptic summary for the entire period is provided at the beginning of each report. Following the summary are sections covering the individual flights. Each section contains the following for a given flight:

- aircraft track for each leg of the flight
- narrative summary of the local weather conditions
- surface analyses and nephanalyses at standard six-hourly synoptic times
- upper air analyses at the 850, 700, 500 and 300 mb levels at standard twelve-hourly synoptic times. (The 200 mb level is included for those series during which research flights were conducted above 300 mbs.)
- 500 mb vertical motion and vorticity patterns at standard twelve-hourly synoptic times
- local area surface analyses at standard three-hourly intervals bracketing the period of each flight
- vertical cross-sections along the flight path for each leg of a flight.

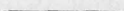
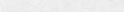


For clarity, no more than two sets of isolines are shown on the upper air charts. All heights are given in geopotential meters above mean sea level (MSL) unless designated otherwise.

The legends for the various charts are given as follows:




<u>CHART</u>	<u>LEGEND</u>
Surface Analysis	 Pressure (millibars) - only the last 2 digits are given  Flight Area (applies to all charts) Fronts, Highs, Lows, Troughs, etc. are depicted according to standard conventions.
Nephanalysis	C Covered (80-100% cloud cover) MCO Mostly Covered (50-80% cloud cover) MOP Mostly Open (20-50% cloud cover) O Open (0-20% cloud cover)  Boundary delineating Covered areas  Boundary delineating Mostly Covered areas  Boundary delineating Mostly Open areas Cb Cumulonimbus Ci Cirriiform Cu Cumuloform St Stratiform Sc Stratocumulus In the above boundaries, the "bumps" point toward areas of lower cloud amounts. Surface Highs, Lows, Fronts, etc., are also depicted on this chart according to standard conventions.
Upper Air Analysis	 Heights (tens of meters) - only 3 digits are given.  Isotachs (meters/second) MAX Isotach Maximum MIN Isotach Minimum

CHARTLEGEND

Upper Air Analysis (cont'd)

	Temperature (degrees Celsius)
	Dew Point Depression (degrees Celsius)
M	Area of relatively moist air
D	Area of relatively dry air
	Vertical Velocity (microbars/second)
+	Upward motion
-	Downward motion
	Vorticity (10^{-5} per second)

Local Surface Analysis

	Pressure (millibars) - only last 2 digits given
	Flight Area
	Precipitation Area

Vertical Cross-Section









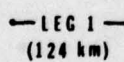
	Half barb = 2.5 meters/second
	Full barb = 5.0 meters/second
	Flag = 25 meters/second
	Temperature (degrees Celsius)
	Dew Point Depression (degrees Celsius)
	Cloud depiction (tops)
	Cloud depiction (bottoms)
	Terrain
	Flight Path - leg number (distance in kilometers)

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1. SYNOPTIC SUMMARY 23-27 MARCH 1978

1.1 Upper Circulation. The period (from 1200Z 23 March through 0000Z 27 March 1978) begins with a ridge over the northwestern section of the United States. A trough is located south of this ridge along the southern tier of the western states. The flow from the Pacific splits and passes north of the ridge and south of the trough, then joining and becoming generally zonal in the eastern half of the country. A jet stream extends from Manitoba, Canada to the Northern Great Lakes region and into the New England States. A weaker jet stream extends from northern Mexico across Texas and through northern Florida. Moisture from the Pacific extends from central California, Oregon and Washington into the central Rockies. Moist air also exists from the Ohio Valley into the northeastern Atlantic states.

As time progresses, the ridge over the northern Rockies weakens, the trough over the southern Rockies deepens and moves eastward, developing into a closed low at all levels of the troposphere, and a ridge begins to build along the West Coast.

By the end of the period, the western states are dominated by a strong ridge, the eastern states are under the influence of a deep trough, and a branch of the northern jet stream extends south-eastward and through this deep trough.

1.2 Surface Pattern. At the beginning of the period the following synoptic situation exists: A low is located over northern New York State with a frontal system trailing toward the southwest into another

low located over Oklahoma. A ridge extends into the north-central section of the United States from Canada. A high is situated over the south Atlantic states. In the west, a cold front lies along the Pacific coast. Skies are generally overcast along the frontal zones and around the lows. Mostly clear skies exist over the ridges except in the southerly flow on the back side of the highs. A wide area of precipitation extends north of the low over Oklahoma.

During the first half of the period, the following synoptic events occur: The low over New York moves into the North Atlantic with its associated frontal system extending westward over Virginia and into the low which has moved from Oklahoma to southern Illinois. The area of precipitation associated with this latter low spreads throughout the Ohio Valley region, with freezing rain occurring over much of Illinois, western Pennsylvania and West Virginia. The ridge near the central Canadian border progresses eastward over the Great Lakes region. The Pacific coast cold front, with a high behind it, moves into the Plains area where the front becomes quasi-stationary and gradually dissipates.

By the end of the period, the major features which dominate the synoptic pattern are as follows: The eastern third of the country is dominated by a complex low and its associated frontal system, with widespread precipitation throughout the north-central Atlantic states and the mid-West. The western two-thirds of the nation is under the influence of a broad but relatively flat ridge.

1.3 Storm Tracks. During the period two storm tracks are seen. One passes along the Canadian border eastward through New England and the other track extends from the Oklahoma panhandle eastward toward the central Atlantic states.

2. FLIGHT 1 23 MARCH 1978

2.1 Aircraft Tracks. The flight tracks of the research aircraft are given below in Table 1. The first three legs of the flight are over Texas. Leg 1 extends from 74 km east of Dalhart to Dalhart, leg 2 is from Dalhart to Amarillo, and leg 3 terminates 68 km northeast of Amarillo, near Borger, Texas. The terrain varies between 1080 and 1220 meters. The next four legs of the flight are flown back and forth between Oswego, Kansas and Okmulgee, Oklahoma. The terrain is between 210 and 305 meters in height.

TABLE 1. AIRCRAFT TRACKS - 23 MARCH 1978

LEG	TIME(Z)		ALTITUDE ft (m)	POSITION		DISTANCE nm (km)
	START	STOP		BEGIN	END	
1	2039	2050	23,700 (7224)	40 nm E DHT ¹	DHT	40 (74)
2	2058	2114	18,300 (5578)	35°54'N 102°22'W	AMA ²	52 (90)
3	2130	2142	9,800 (2987)	10 mn N AMA	35°43'N 101°14'W	32 (59)
4	2240	2302	23,600 (7193)	OSWEGO,KS ³	OKMULGEE,OK ⁴	95 (176)
5	2309	2333	18,300 (5578)	OKMULGEE	OSWEGO	95 (176)
6	2343	0005	10,000 (3048)	OSWEGO	OKMULGEE	95 (176)
7	0019	0040	4,800 (1463)	OKMULGEE	OSWEGO	95 (176)

¹DHT=Dalhart, TX (36°05'N 102°33'W).

²AMA=Amarillo, TX (35°17'N 101°38'W)

³OSWEGO,KS (37°09'N 95°12'W)

⁴OKMULGEE,OK (35°40'N 95°57'W)

2.2 Local Synoptic Summary. At the surface a low over central Oklahoma and its associated frontal system affects the flight areas

(Figure 1). The flight area remains under the influence of a broad trough which gradually develops into a closed circulation during the flight period (Figures 2 through 4). Overcast conditions, consisting of cumuloform clouds and stratiform layers, prevail over the flight areas throughout the entire day of the flight (Figures 5 through 8).

The 850 millibar (mb) level shows a closed low moving eastward and lying just south of the flight areas during the flight period (Figures 9 and 11). This low is reflected through 300 mb sloping to the west with height. Cold air moves in behind the low with widespread moisture over the flight region (Figures 10 and 12).

At 700 mb, a broad trough reflecting the 850 mb level low moves into the flight area from the west and deepens. An area of 20 meters per second (msec^{-1}) winds moves to a position south of the flight regions from the southwest. Colder moist air accompanies the trough (Figures 13 through 16).

The trough at 500 mb also deepens as it moves into the flight area. Winds increase from 20 msec^{-1} to 30 msec^{-1} just south of Oklahoma near the flight tracks. Temperatures decrease and relative humidity increases with the approach of the trough over the area of interest (Figures 17 through 21). The 500 mb level shows an area of upward vertical motion passing eastward through the flight region. Positive vorticity is advected into the flight area (Figures 21 and 22).

At 300 mb the trough lies along the Arizona-New Mexico border with a 45 msec^{-1} isotach maximum along the Mexican boundary (Figure 23). The coldest air is centered along the trough (Figure 24). The trough deepens and moves eastward over the Texas panhandle with little change in temperature (Figures 25 and 26).

The local surface charts (Figures 27 through 29) show the flight areas under the influence of a low pressure system and its associated frontal zone. Overcast clouds prevail over the entire area with a broad band of precipitation extending along the north of the frontal zone. Widespread thunderstorm and shower activity is reported.

For the first three legs of the flight, the wind cross-section (Figure 30) indicates the trough at the levels above 700 mbs is near the flight tracks, but lies to the east of the flight tracks at the lower levels. Clouds are layered from about 180 meters above the terrain to 5.8 km (Figure 31). Imbedded cumuloform clouds (not shown) could extend the moist layer to above 7.5 km. The first freezing level is at 1200 meters with a warm layer (above 0°C) between 1400 and 3000 meters. The last four legs of the flight are flown east of the trough-line. Temperatures are generally 5°C warmer with a deeper layer of moisture up to 7.8 km as compared to the previous three legs (Figures 32 through 35).

A simple tropopause is located at 9.9 km with temperatures near -55°C at the beginning of leg 1 of the flight. The tropopause

lowers to 9.7 km with slight warming to -54°C by the end of leg 3. Over the next segments of the flight, the tropopause is at 11.5 km with a temperature of -60°C over the southwest end of the flight tracks and raises to 11.7 km with a temperature of -62°C at the northeast end of the tracks. Little change occurs in these values during the flight period.

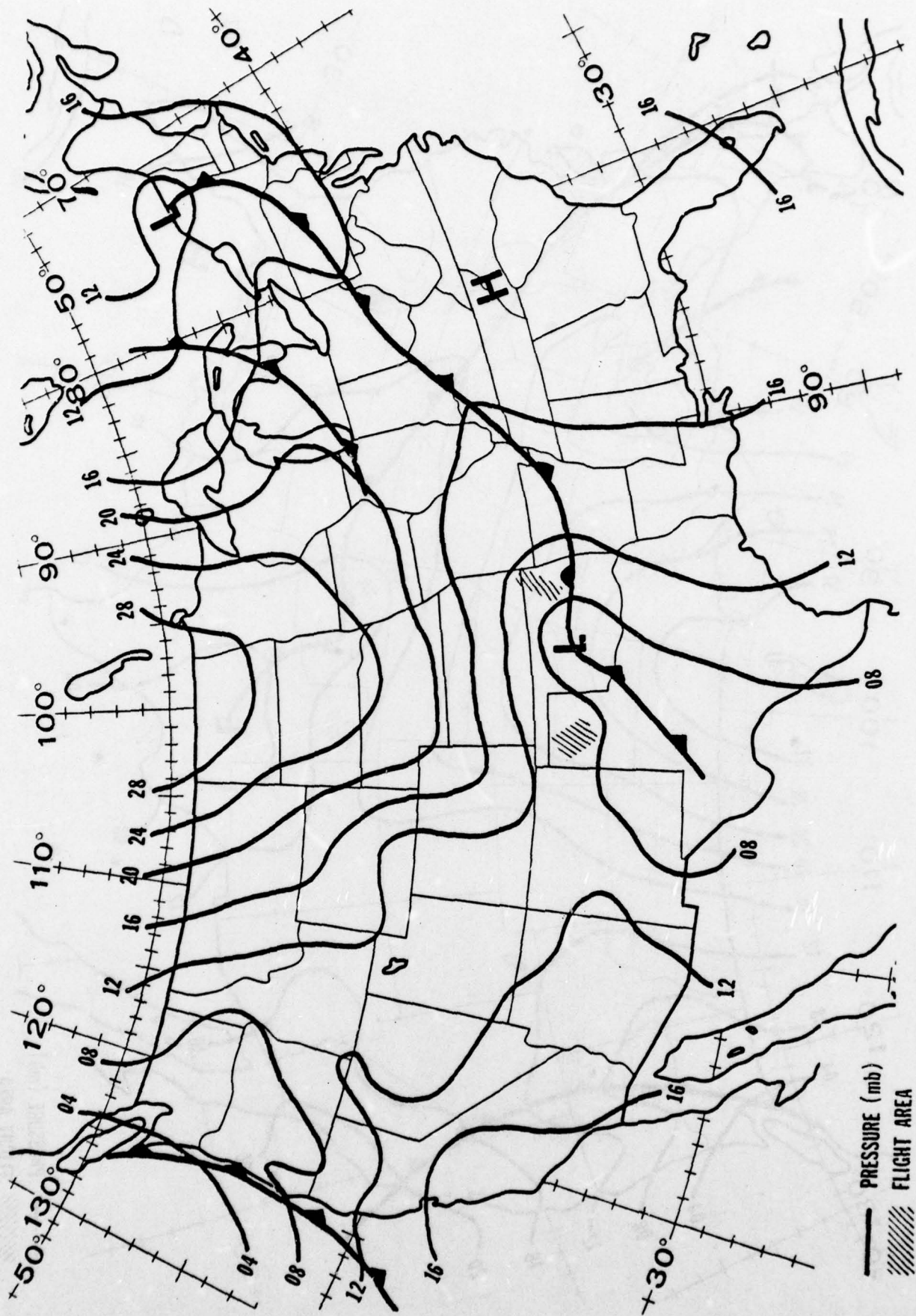


Figure 1. SURFACE PRESSURE - 23 MAR 78 12Z ANALYSIS

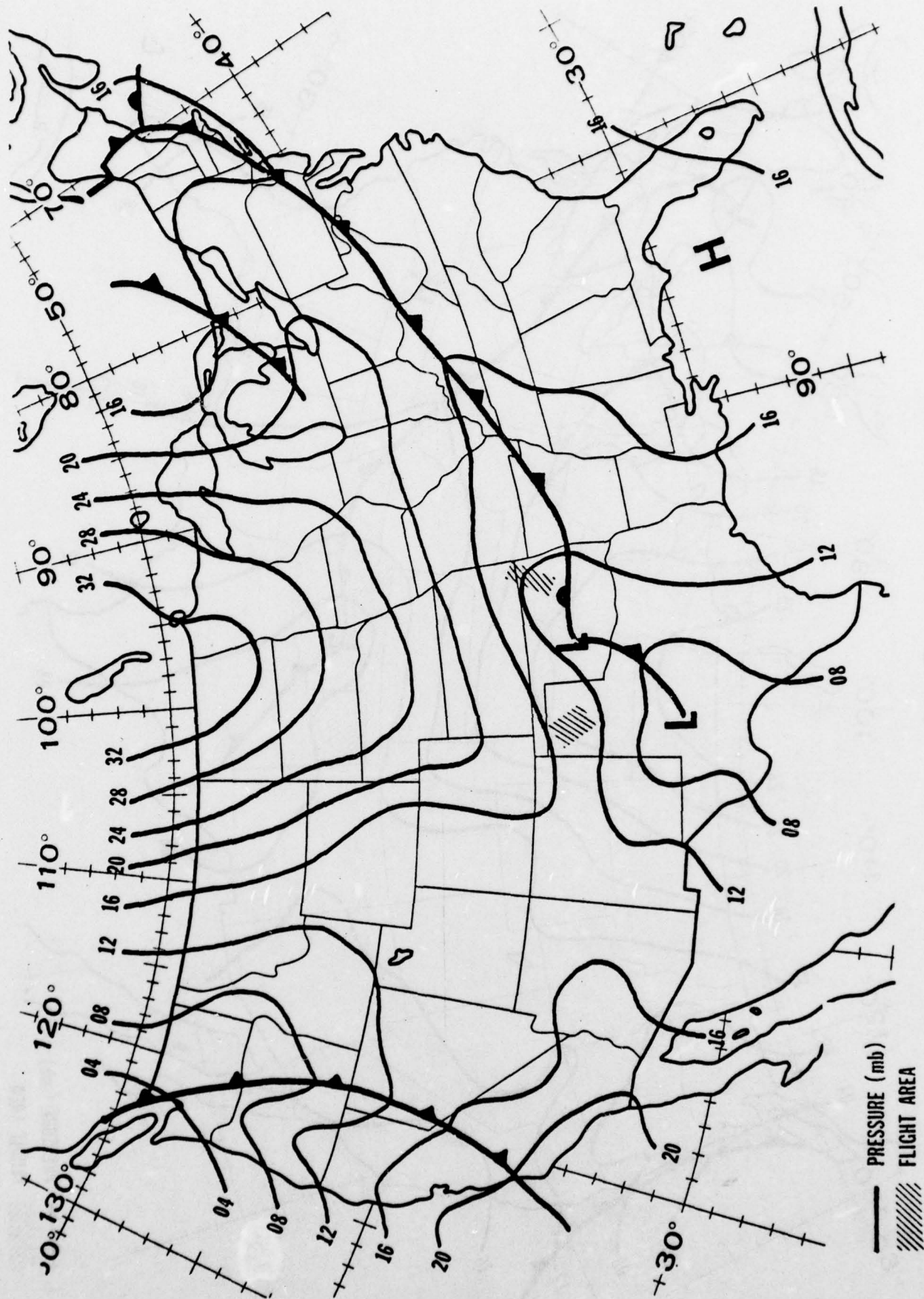


Figure 2. SURFACE PRESSURE - 23 MAR 78 18Z ANALYSIS

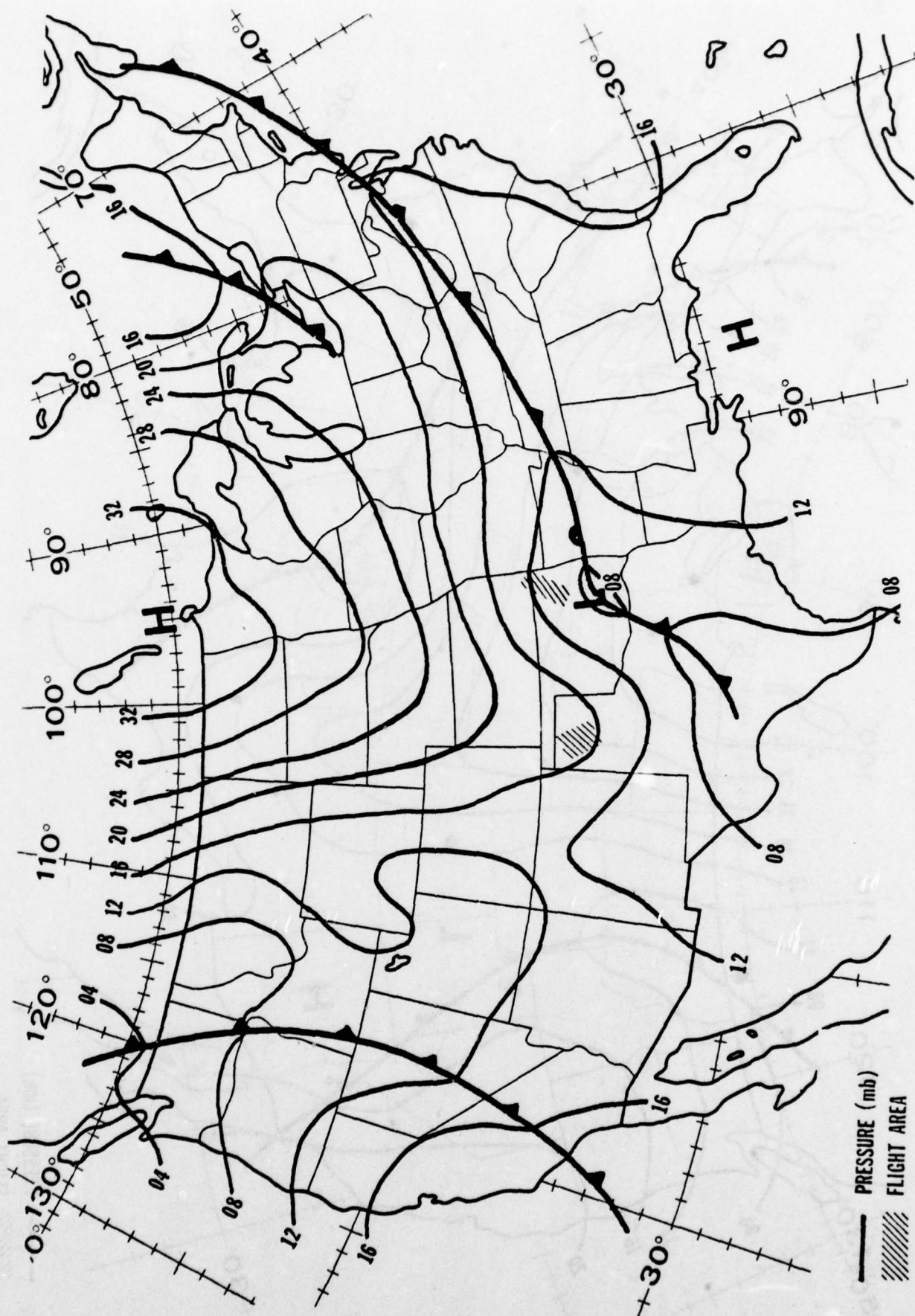


Figure 3. SURFACE PRESSURE - 24 MAR 78 00Z ANALYSIS

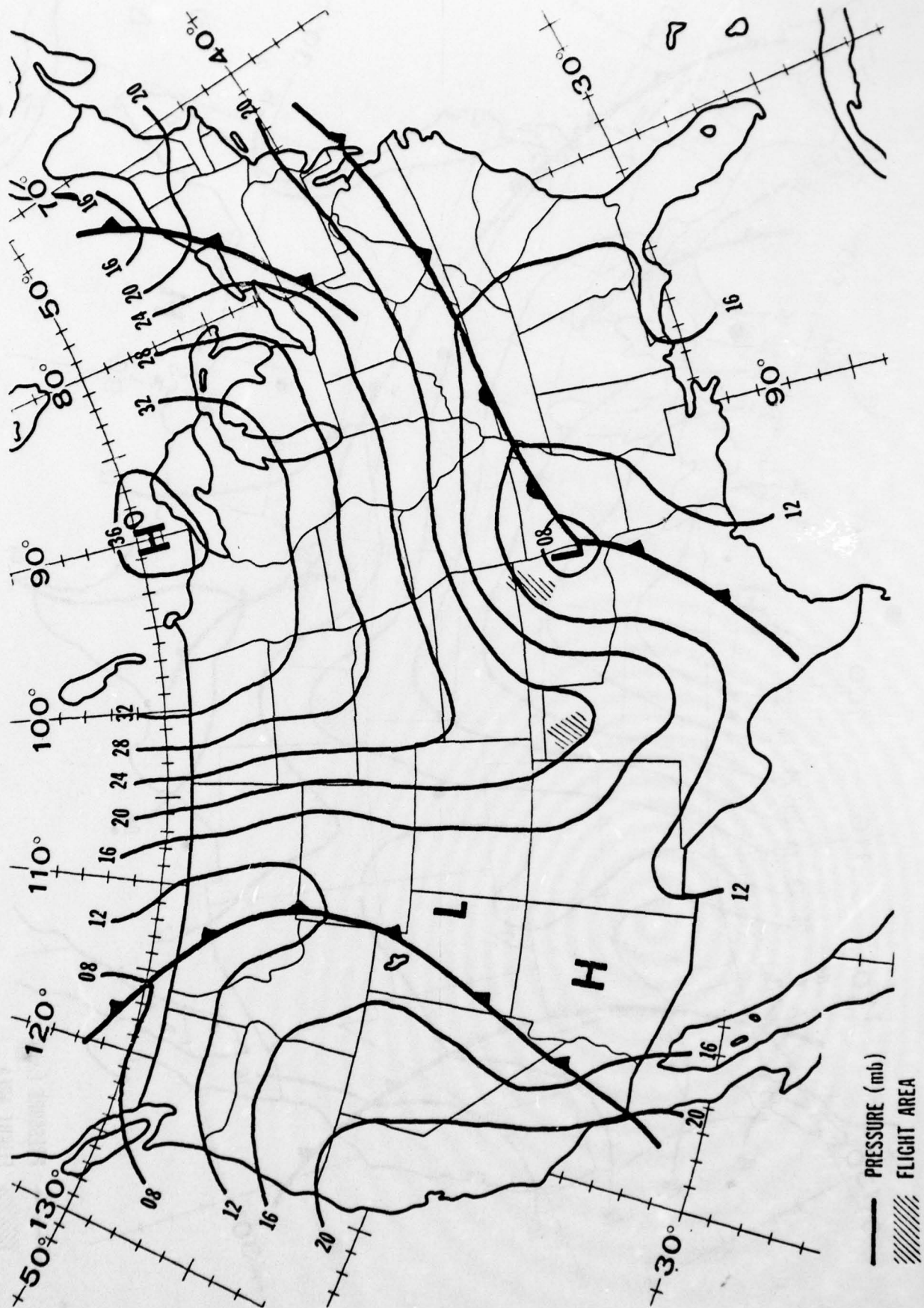


Figure 4. SURFACE PRESSURE - 24 MAR 78 06Z ANALYSIS

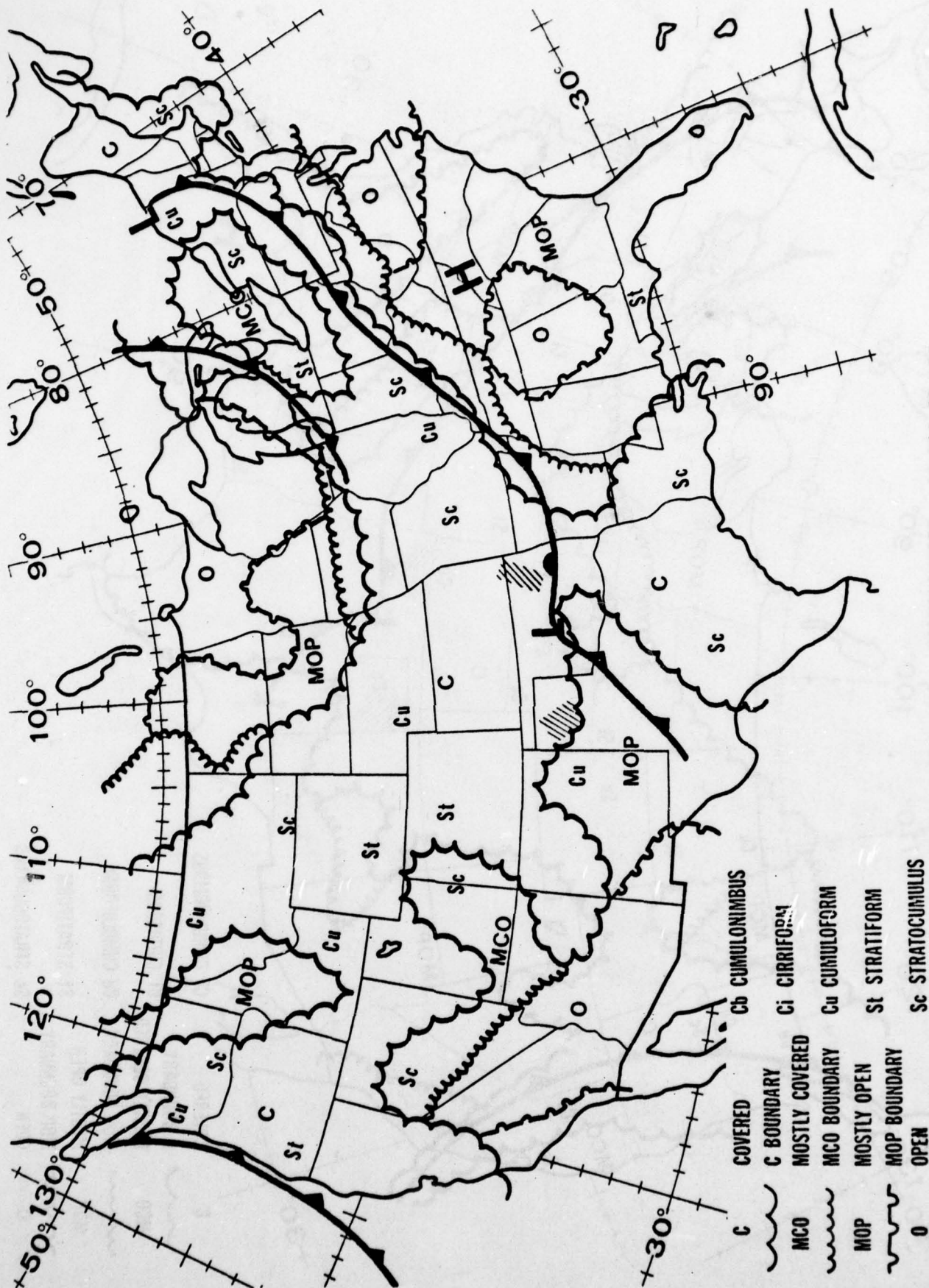


Figure 5. NEPHANALYSIS - 23 MAR 78 12Z

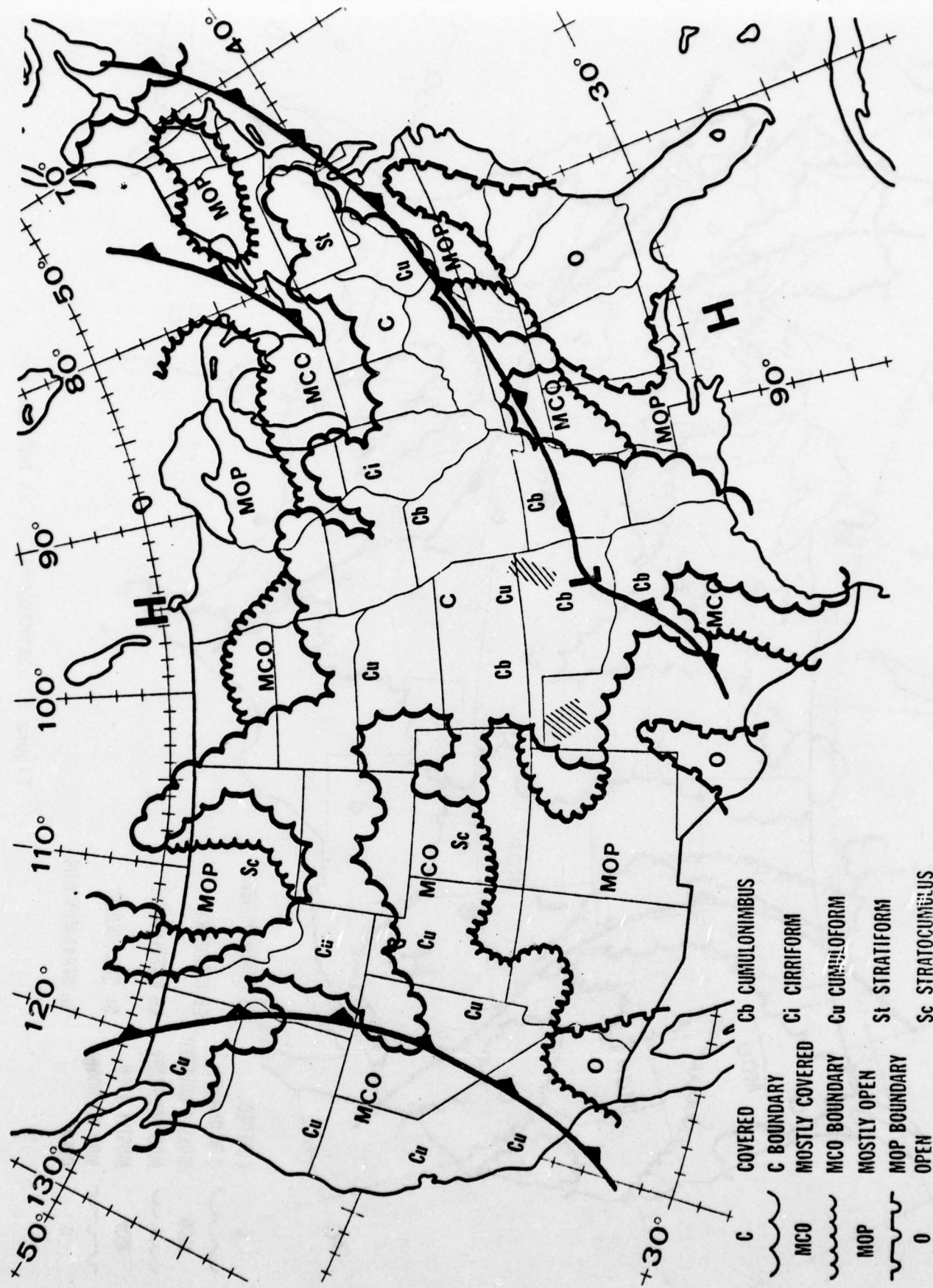


Figure 7. NEPHANALYSIS - 24 MAR 78 00Z

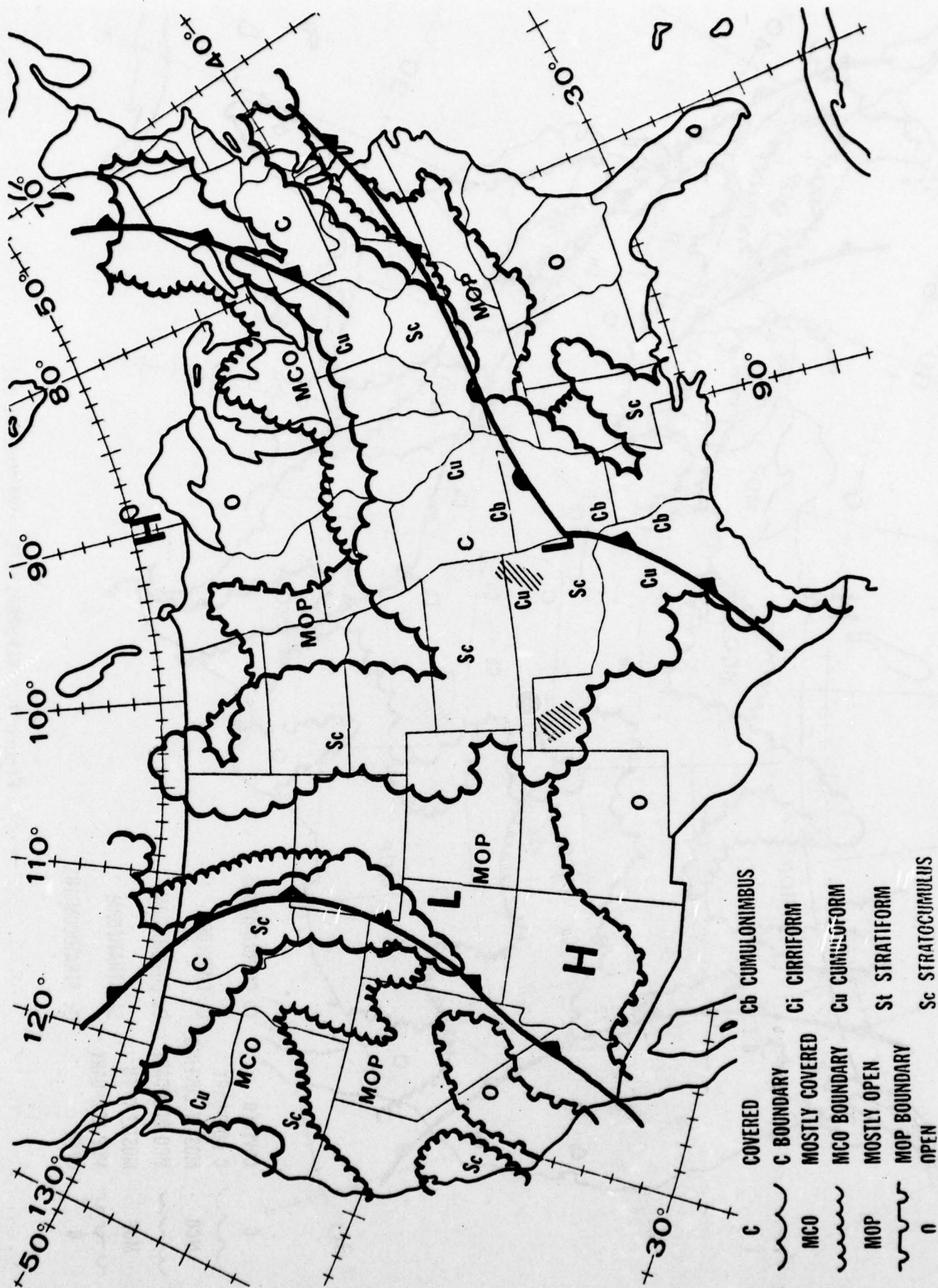


Figure 8. NEPHANALYSIS - 24 MAR 78 06Z

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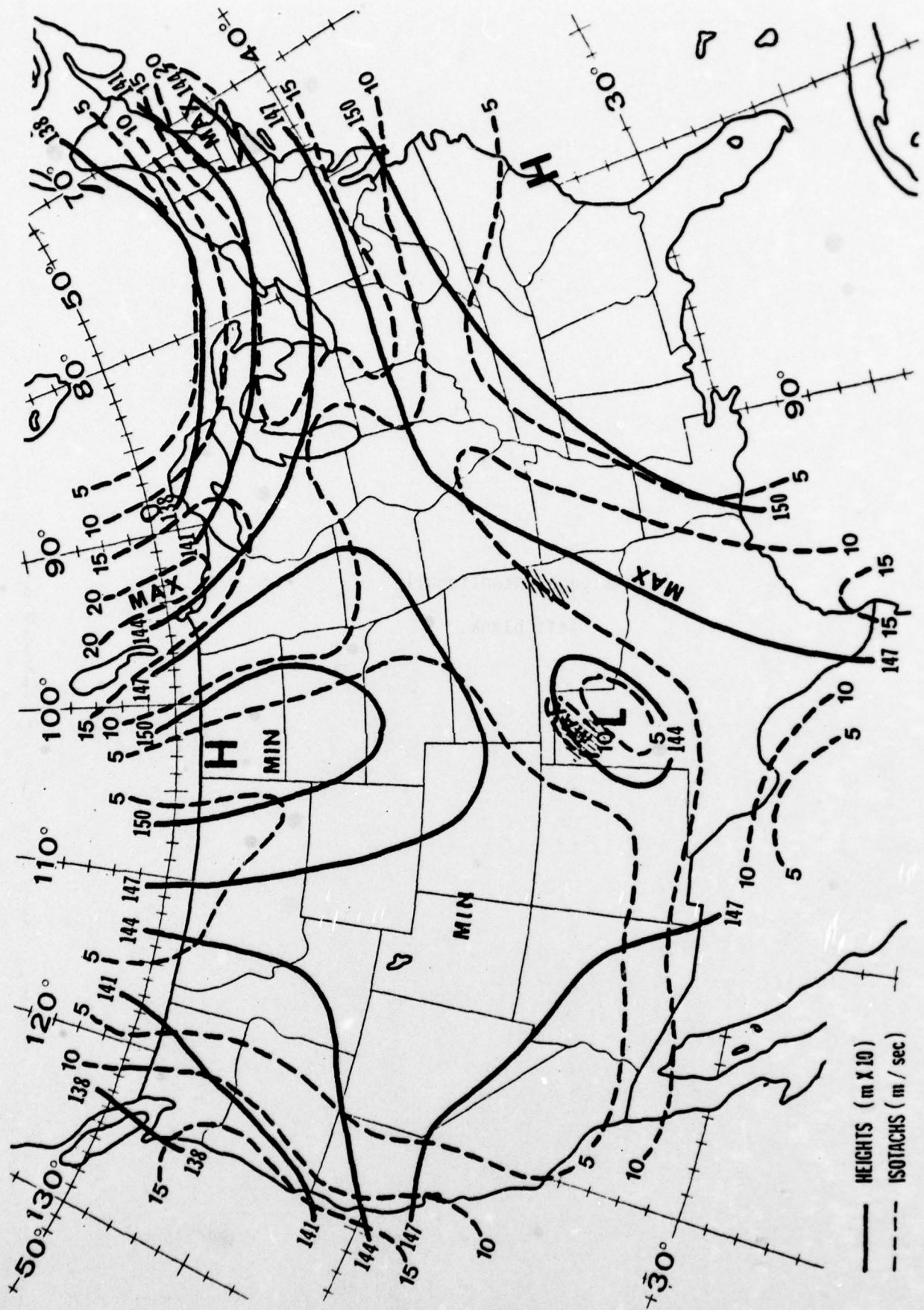


Figure 9. 850 mb HEIGHTS/ISOTACHS - 23 MAR 78 12Z ANALYSIS



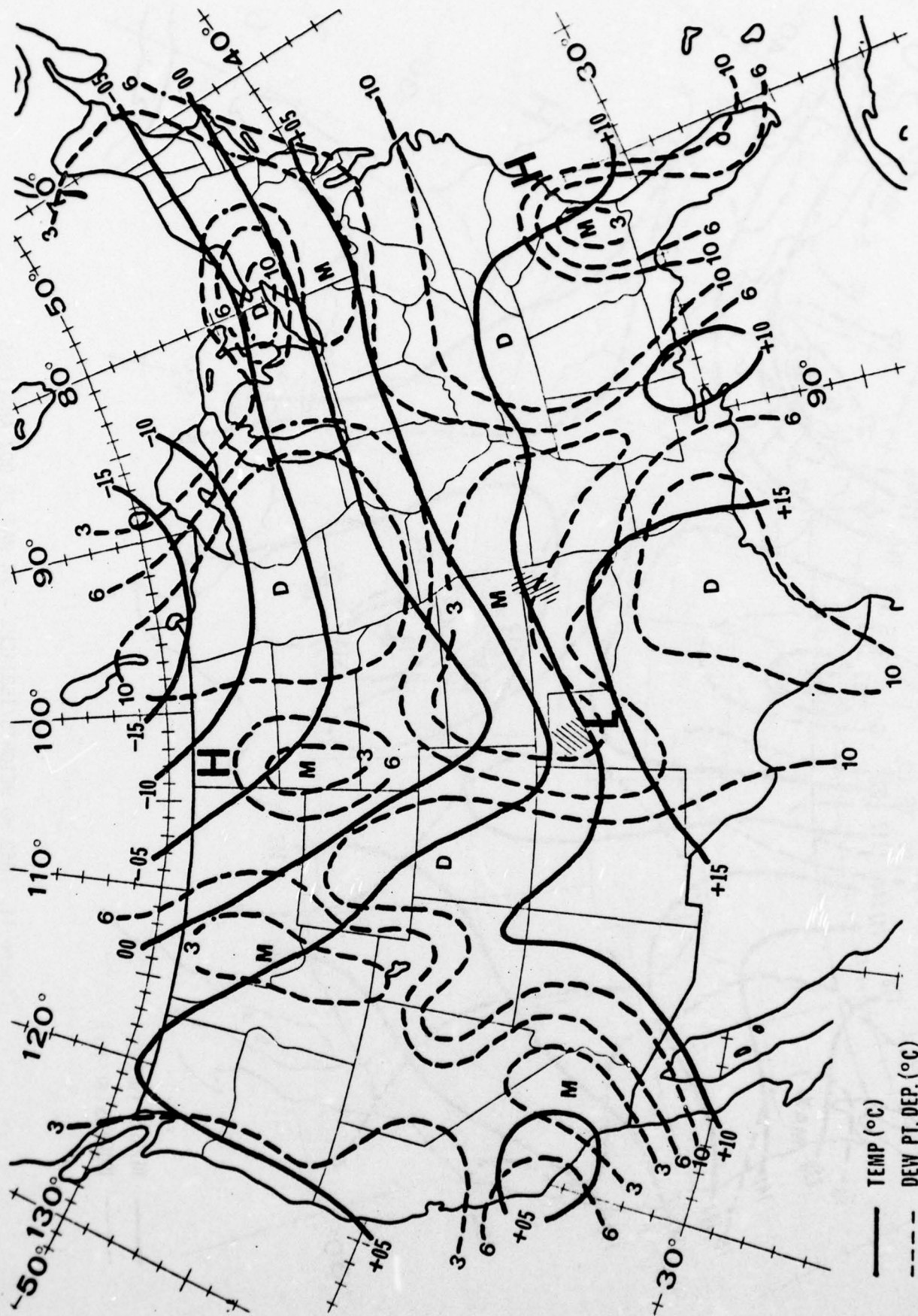


Figure 10. 850 mb TEMP./DEW PT. DEPRESSION - 23 MAR 78 12Z ANALYSIS

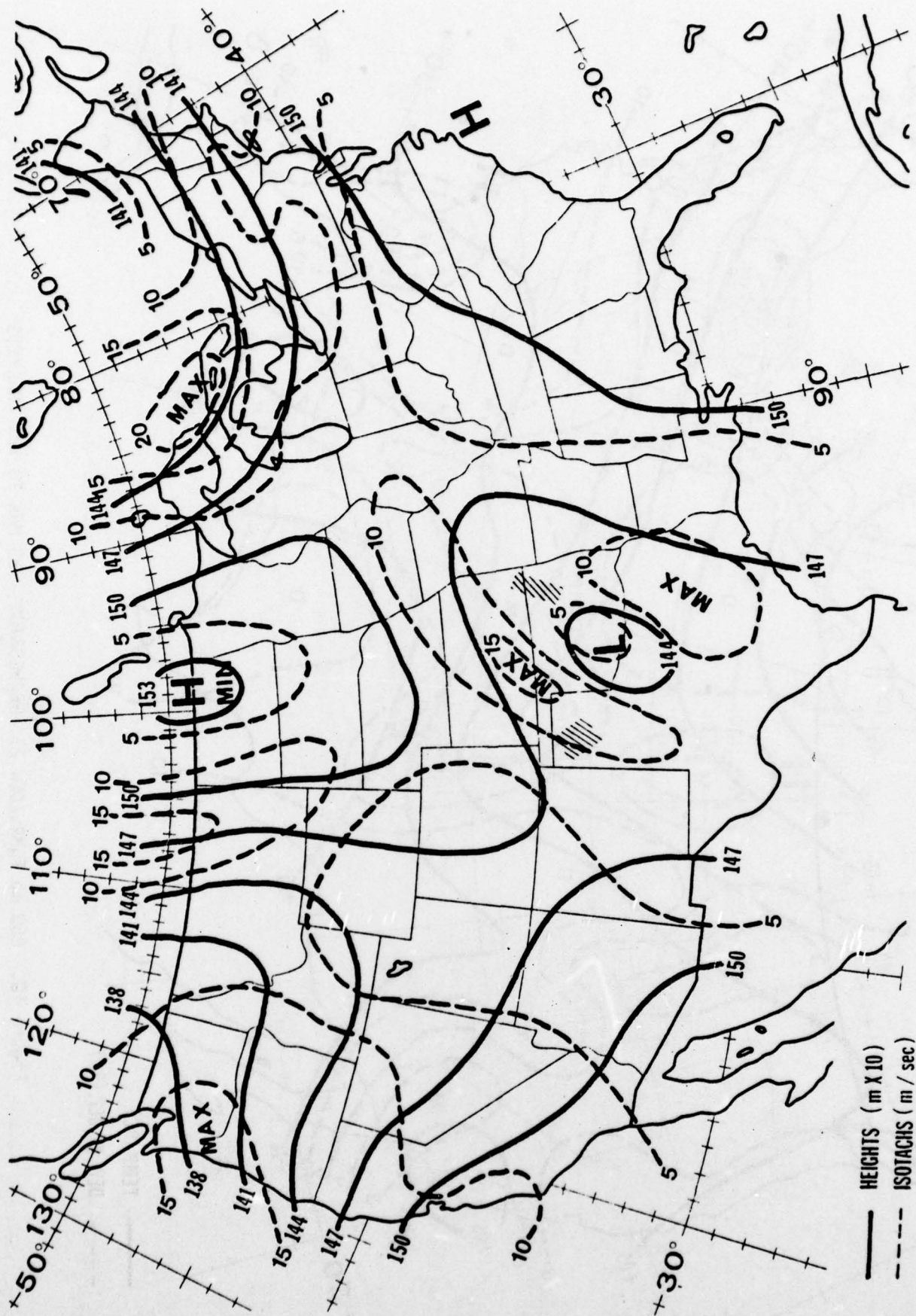


Figure 11. 850 mb HEIGHTS/ISOTACHS - 24 MAR 78 00Z ANALYSIS

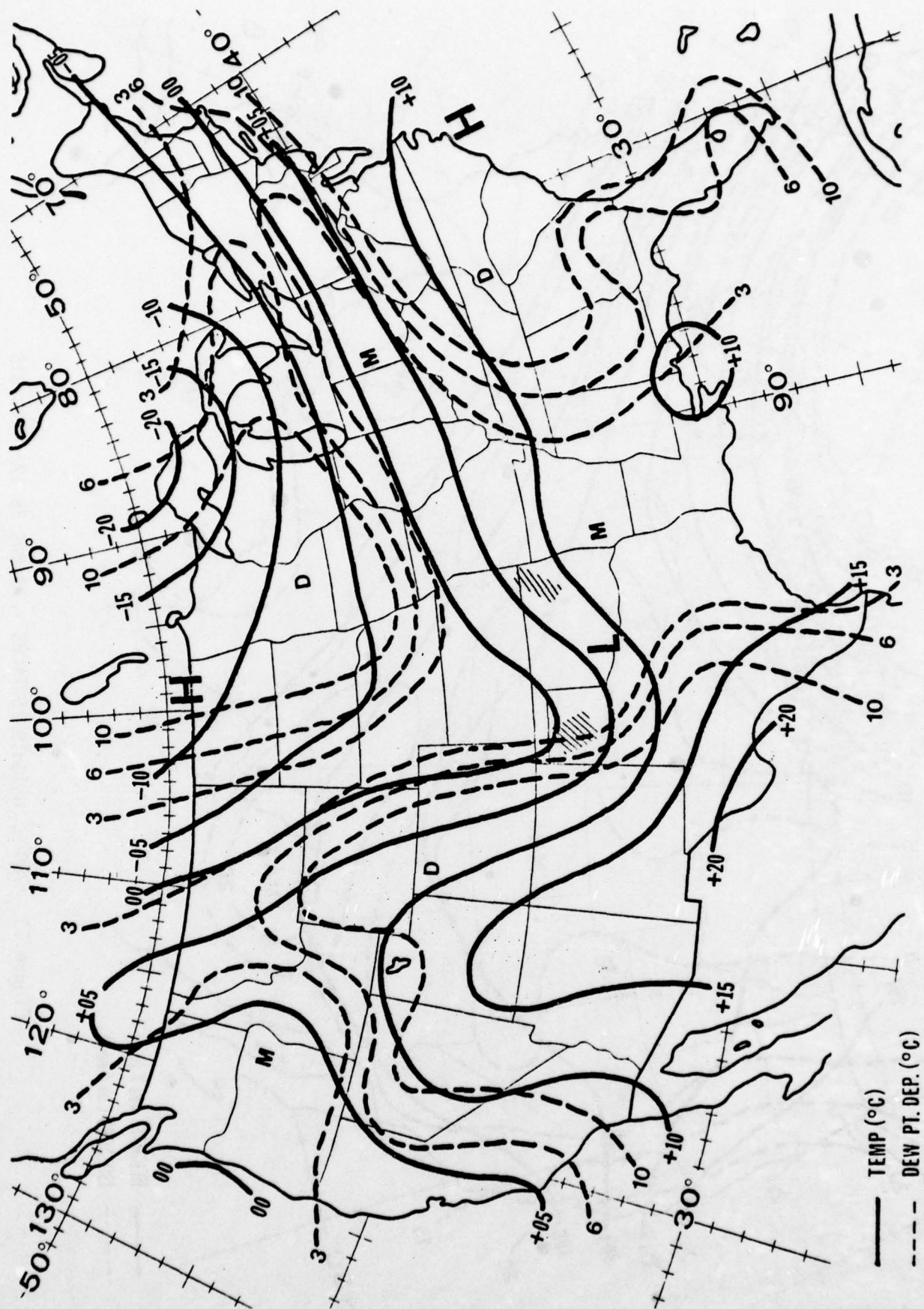


Figure 12. 850 mb TEMP./DEW PT. DEPRESSION - 24 MAR 78 00Z ANALYSIS

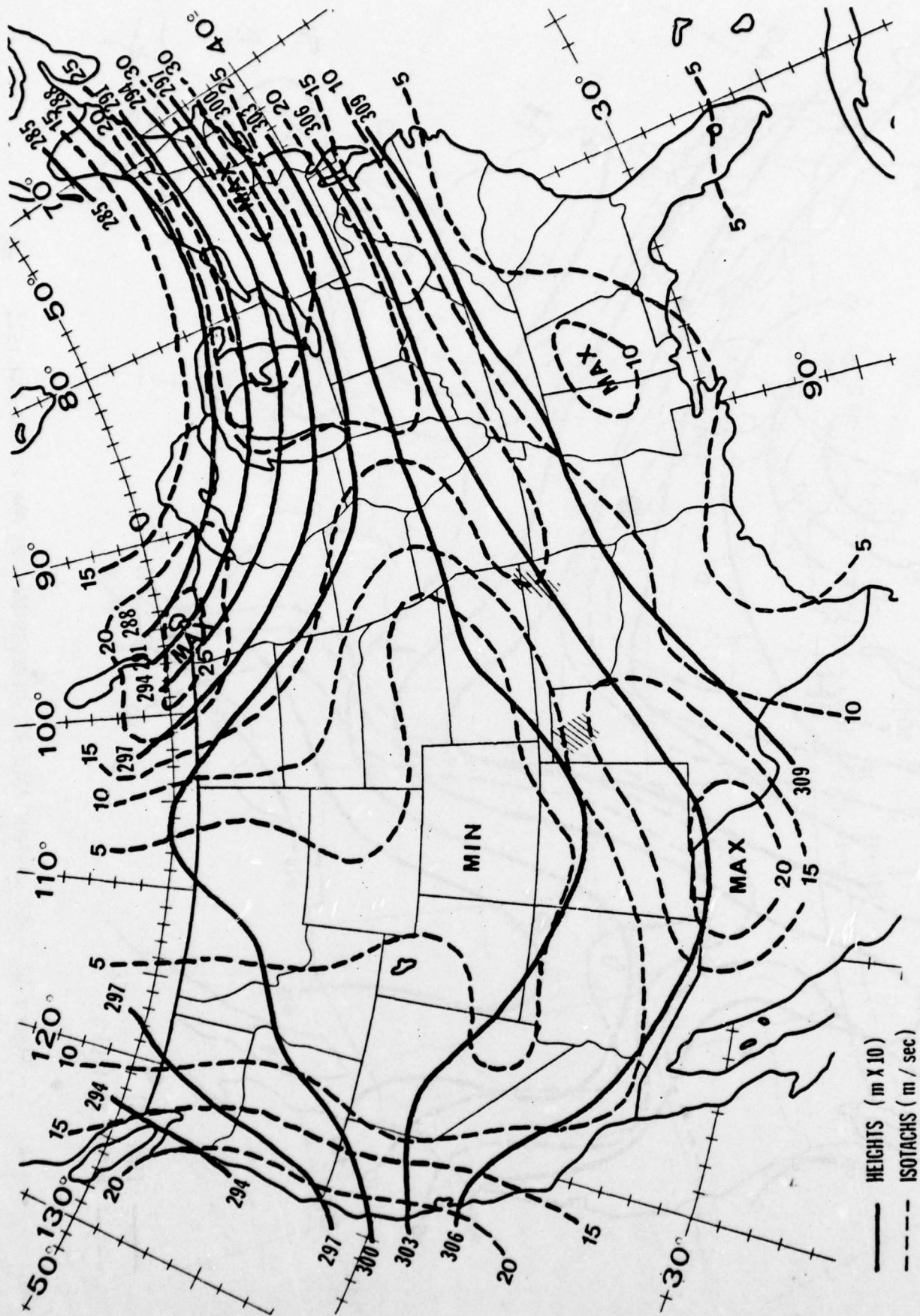


Figure 13. 700 mb HEIGHTS/ISOTACHS - 23 MAR 78 12Z ANALYSIS

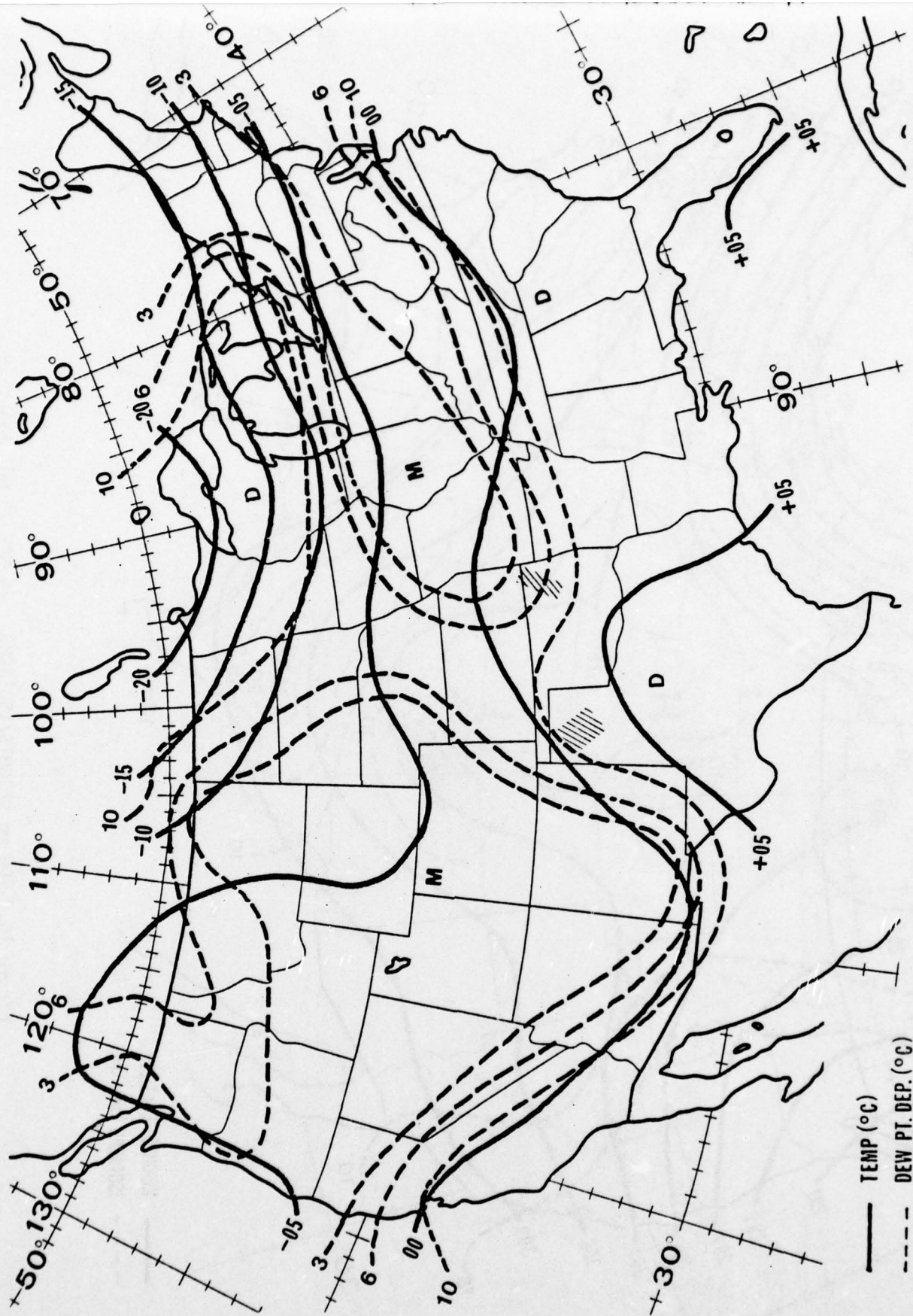


Figure 14. 700 mb TEMP./DEW PT. DEPRESSION - 23 MAR 78 12Z ANALYSIS

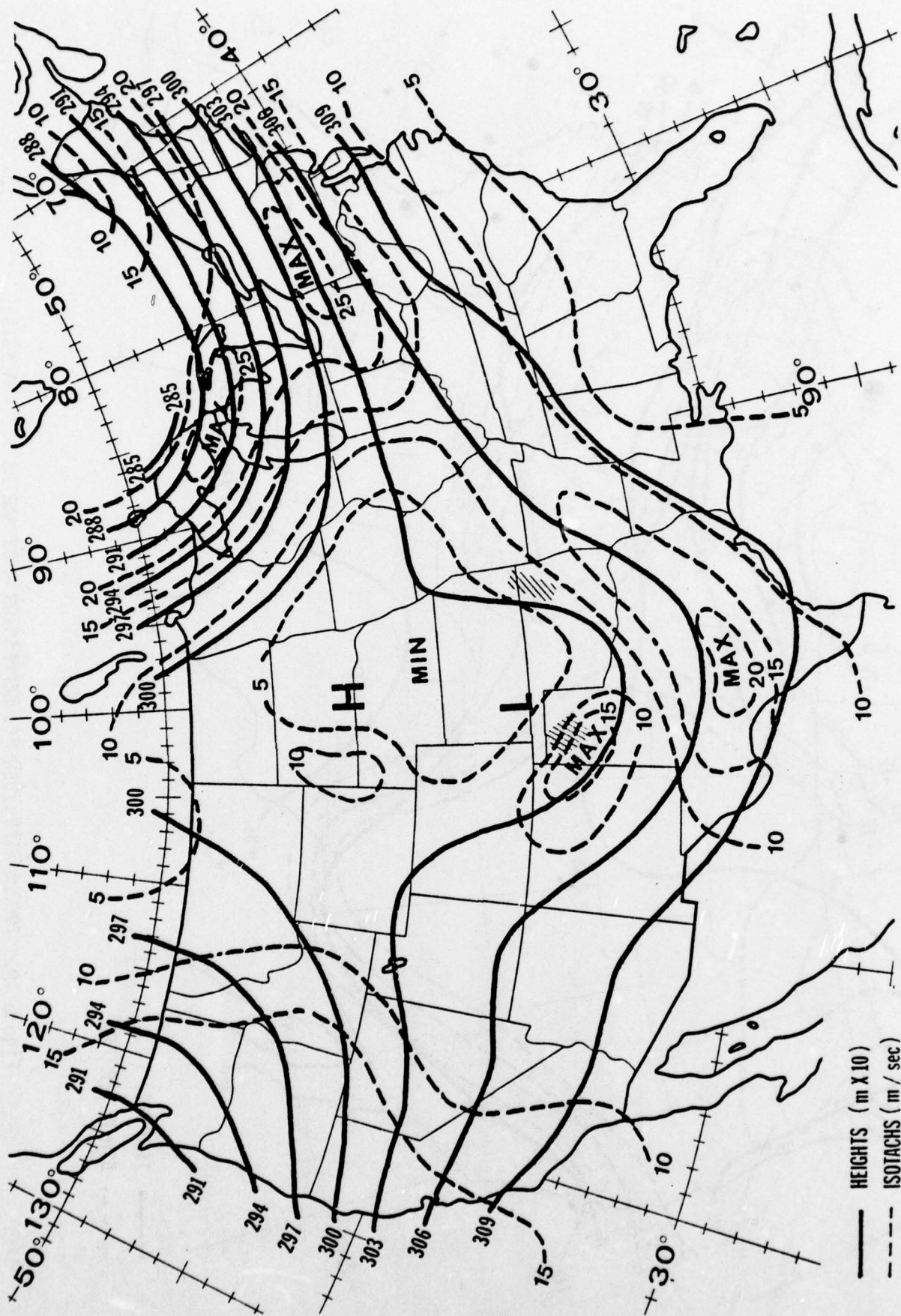


Figure 15. 700 mb HEIGHTS/ISOTACHS - 24 MAR 78 00Z ANALYSIS

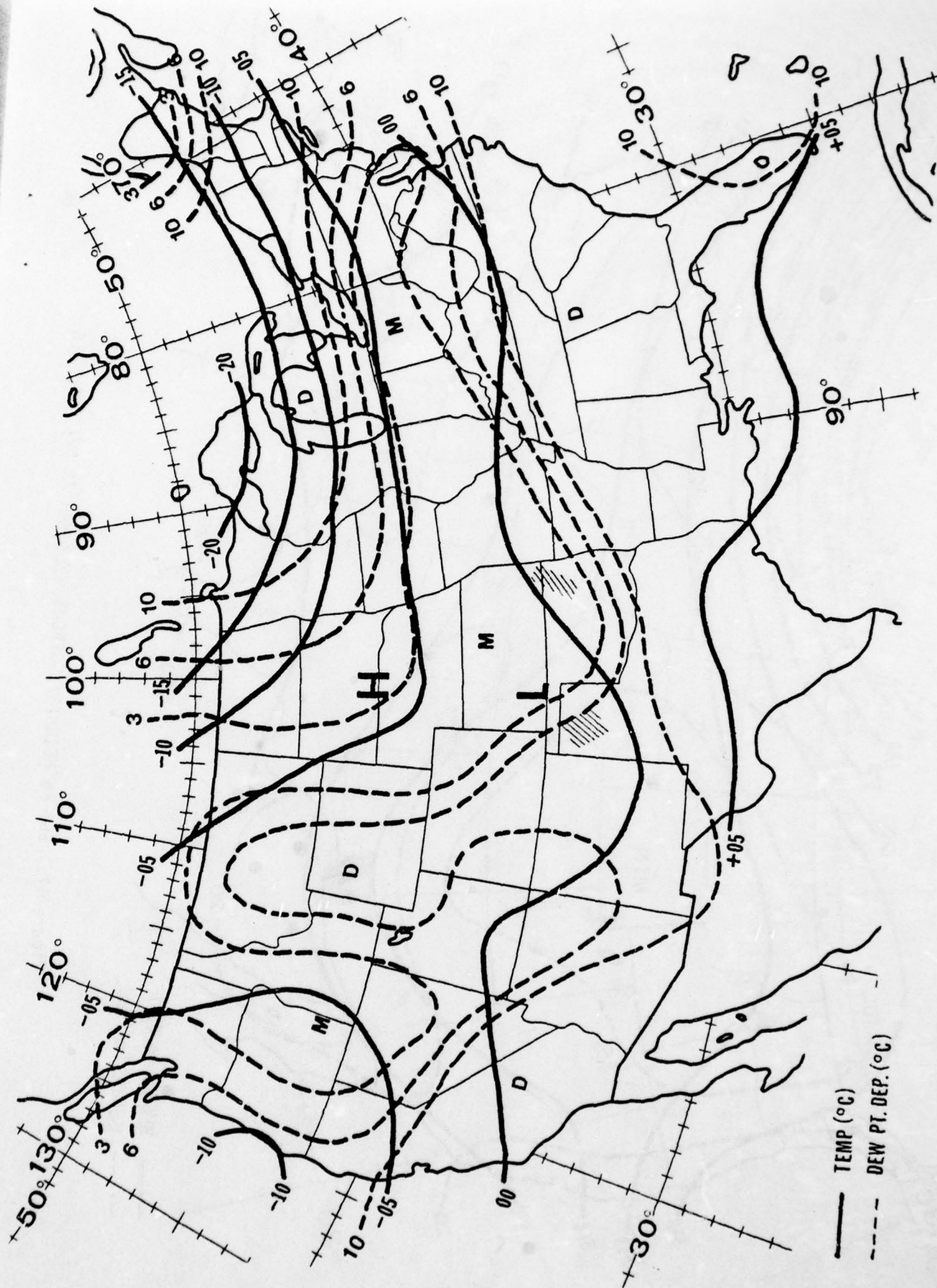


Figure 16. 700 mb TEMP./DEW PT. DEPRESSION.

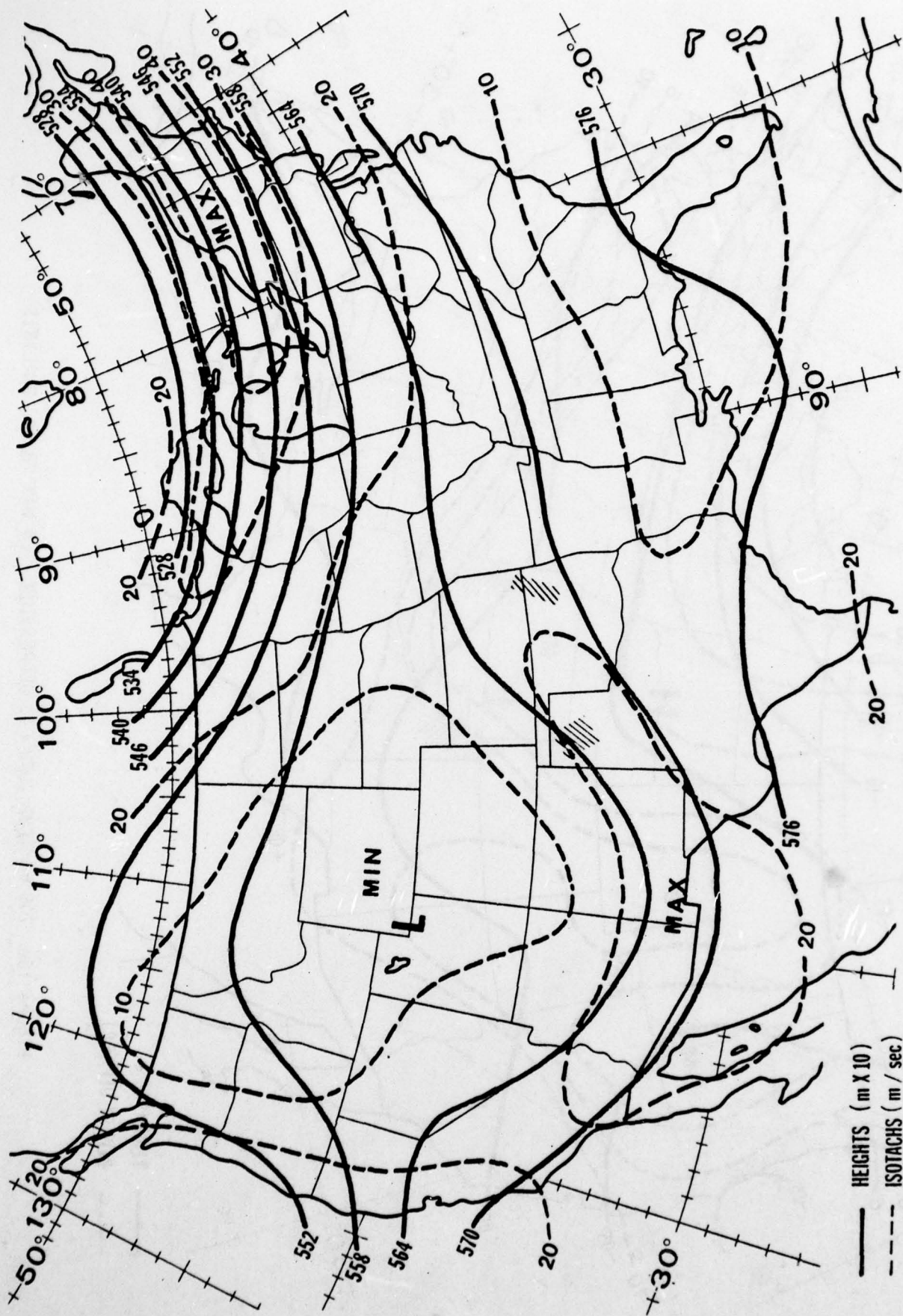


Figure 17. 500 mb HEIGHTS/ISOTACHS - 23 MAR 78 12Z ANALYSIS

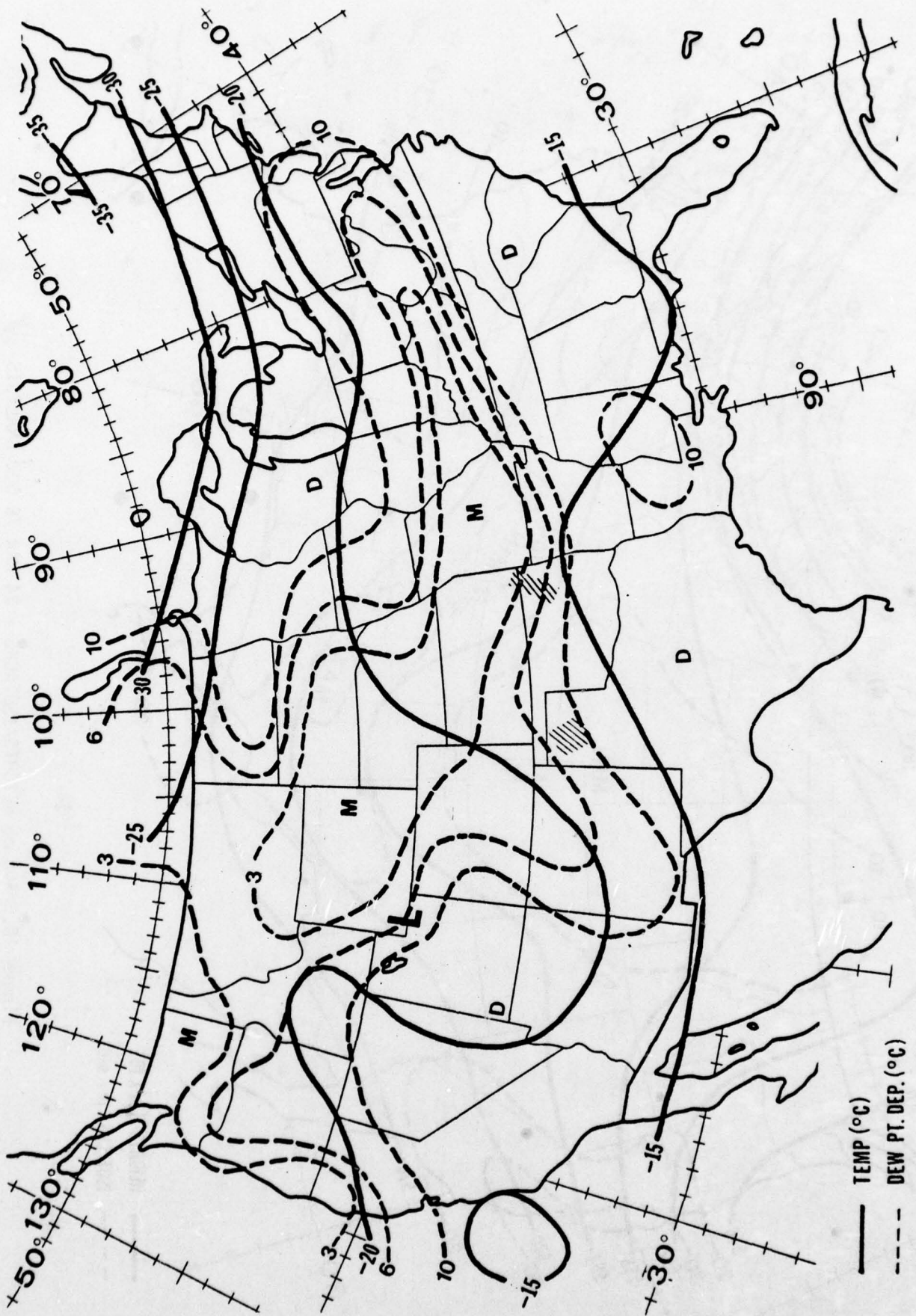


Figure 18. 500 mb TEMP./DEW PT. DEPRESSION - 23 MAR 78 12Z ANALYSIS

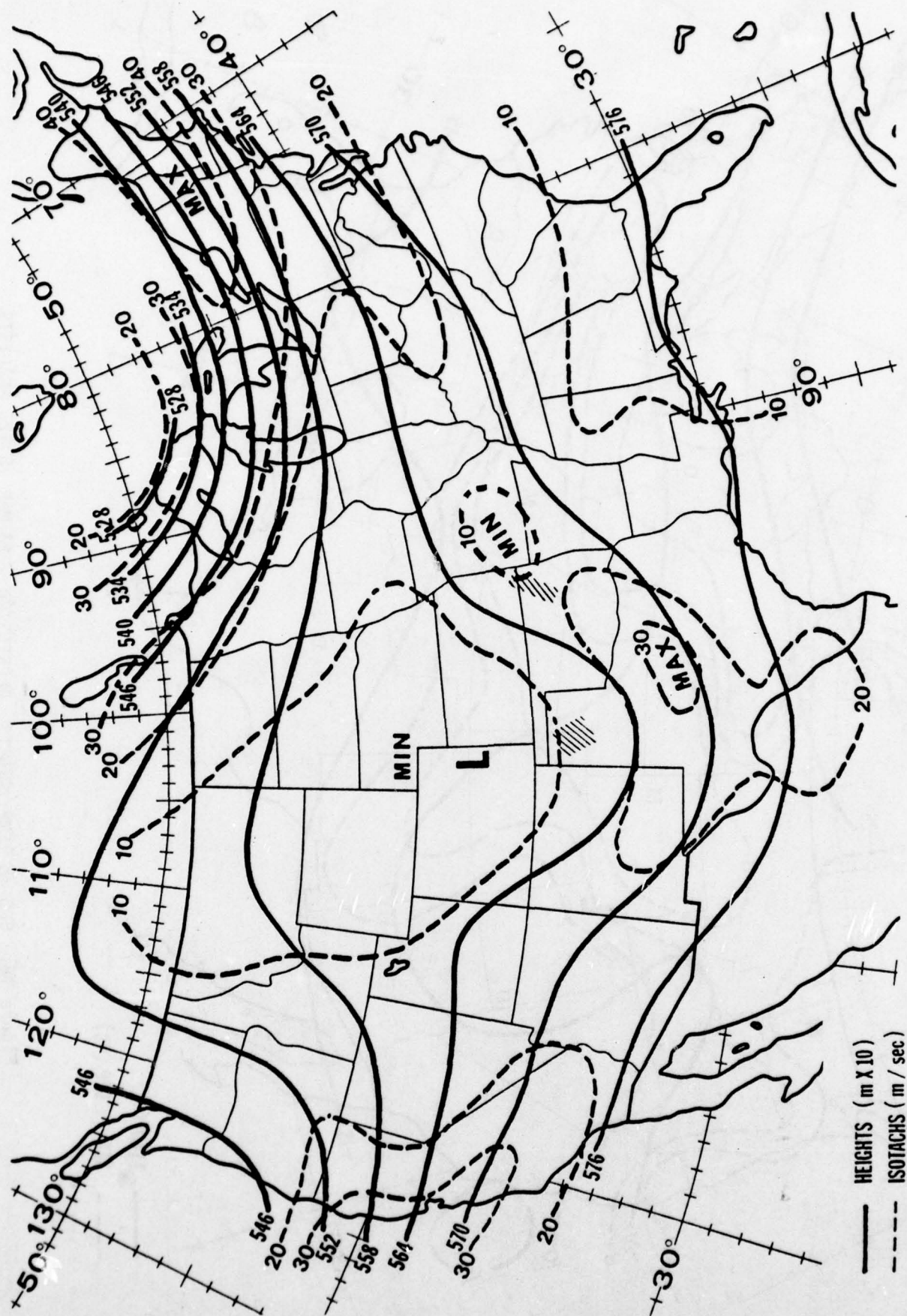


Figure 19. 500 mb HEIGHTS/ISOTACHS - 24 MAR 78 00Z ANALYSIS

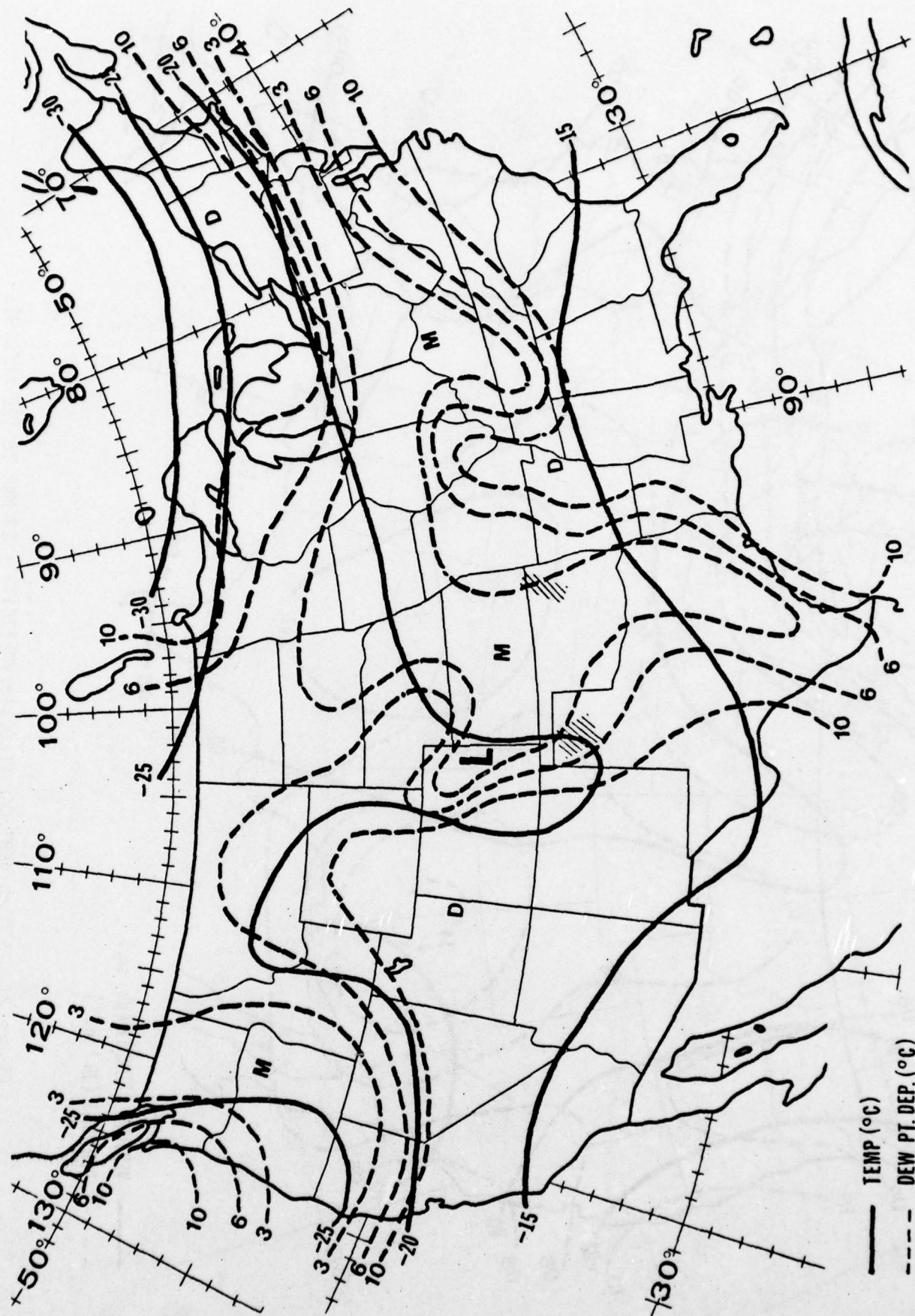


Figure 20. 500 mb TEMP./DEW PT. DEPRESSION - 24 MAR 78 00Z ANALYSIS

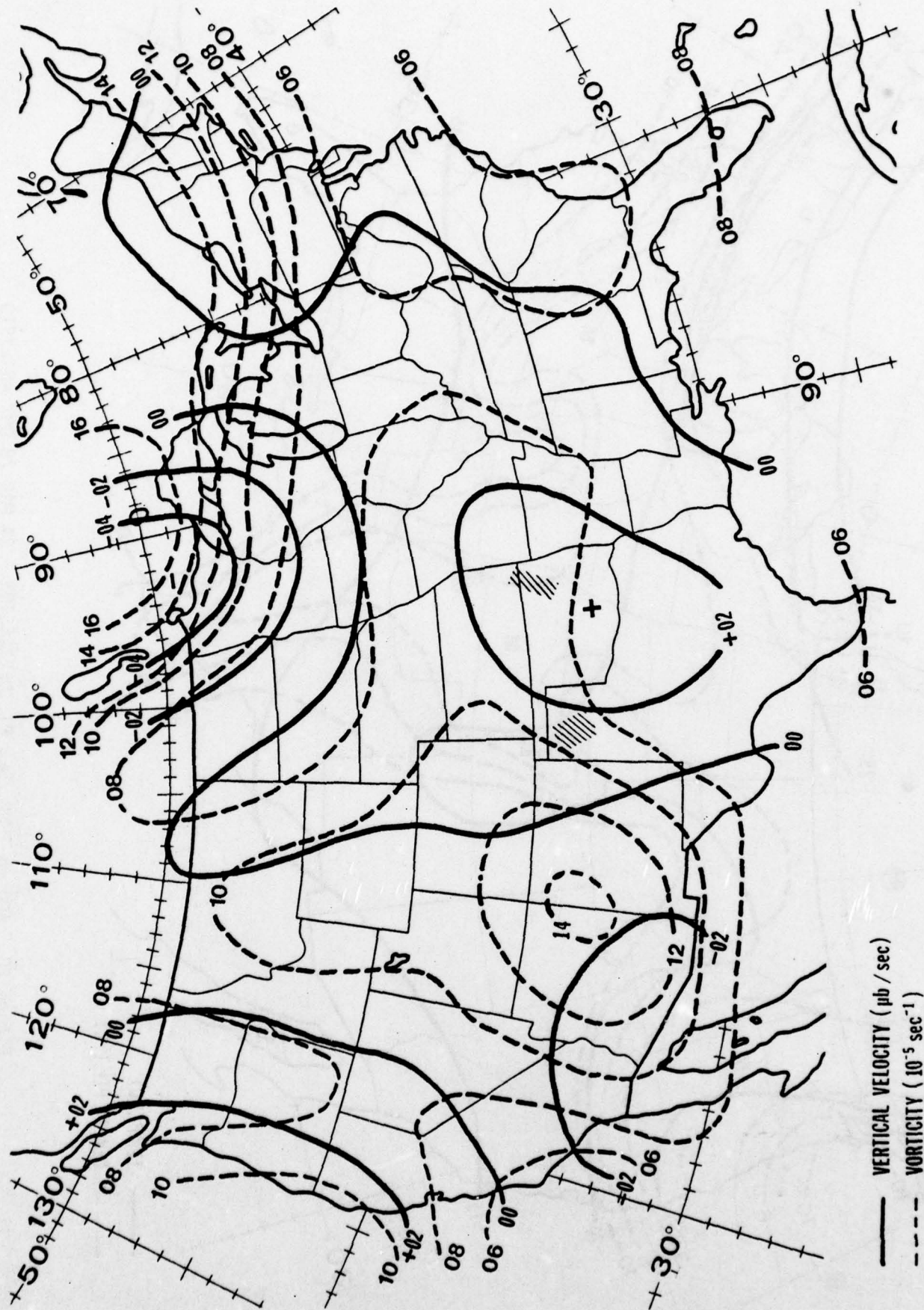


Figure 21. 500 mb VERTICAL VELOCITY/VORTICITY - 23 MAR 78 12Z ANALYSIS

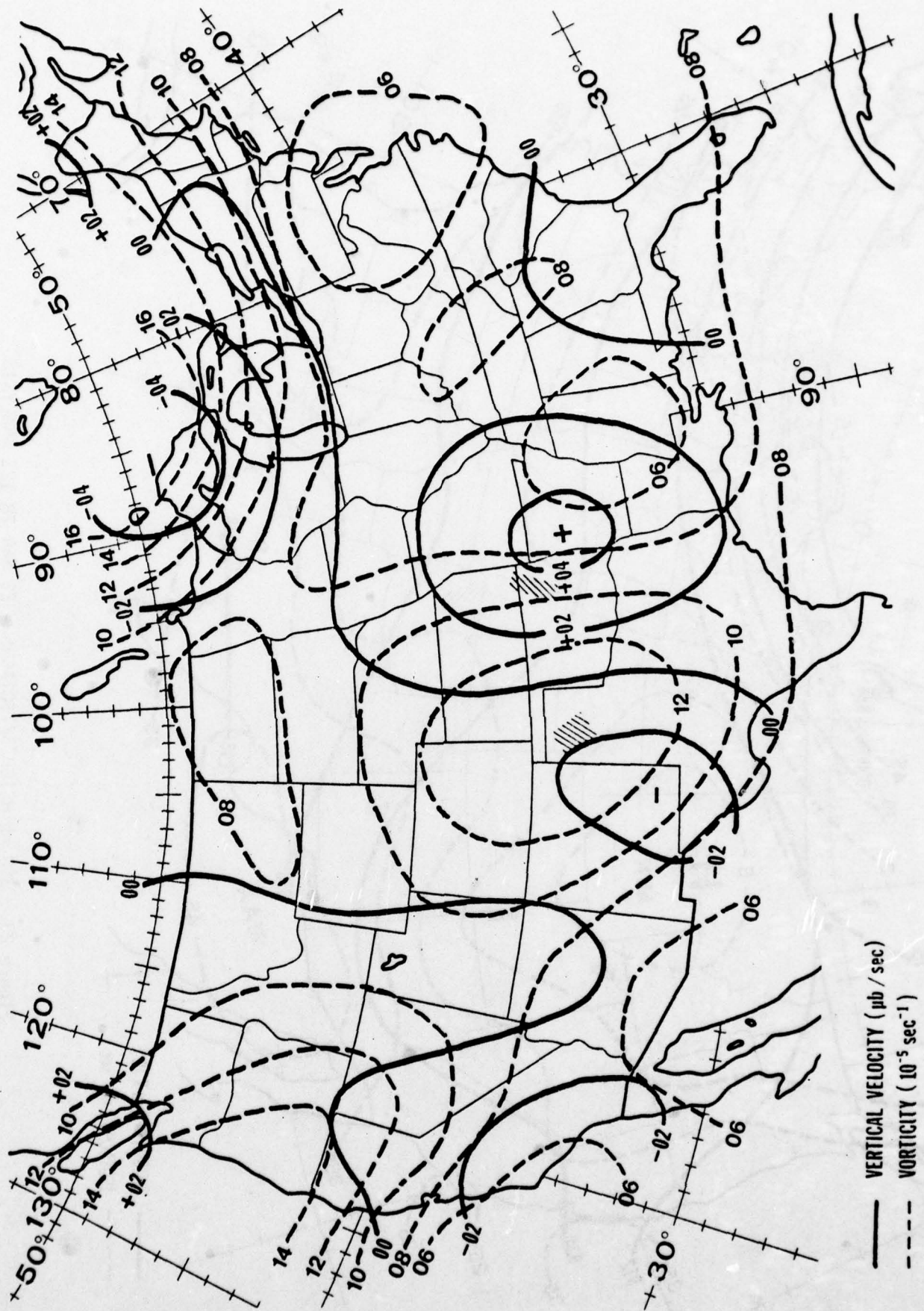


Figure 22. 500 mb VERTICAL VELOCITY/VORTICITY - 24 MAR 78 00Z ANALYSIS

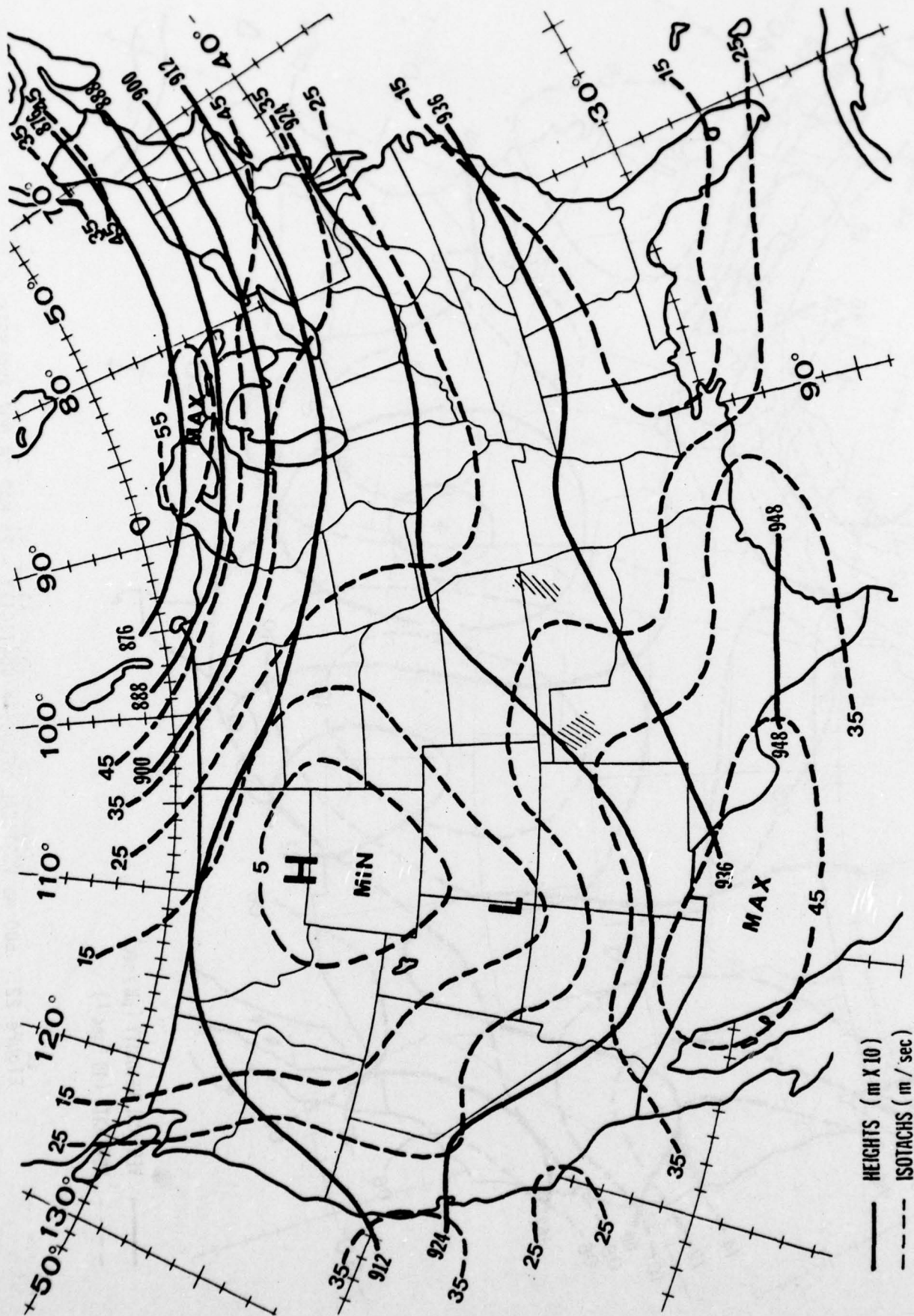


Figure 23. 300 mb HEIGHTS/ISOTACHS - 23 MAR 78 12Z ANALYSIS

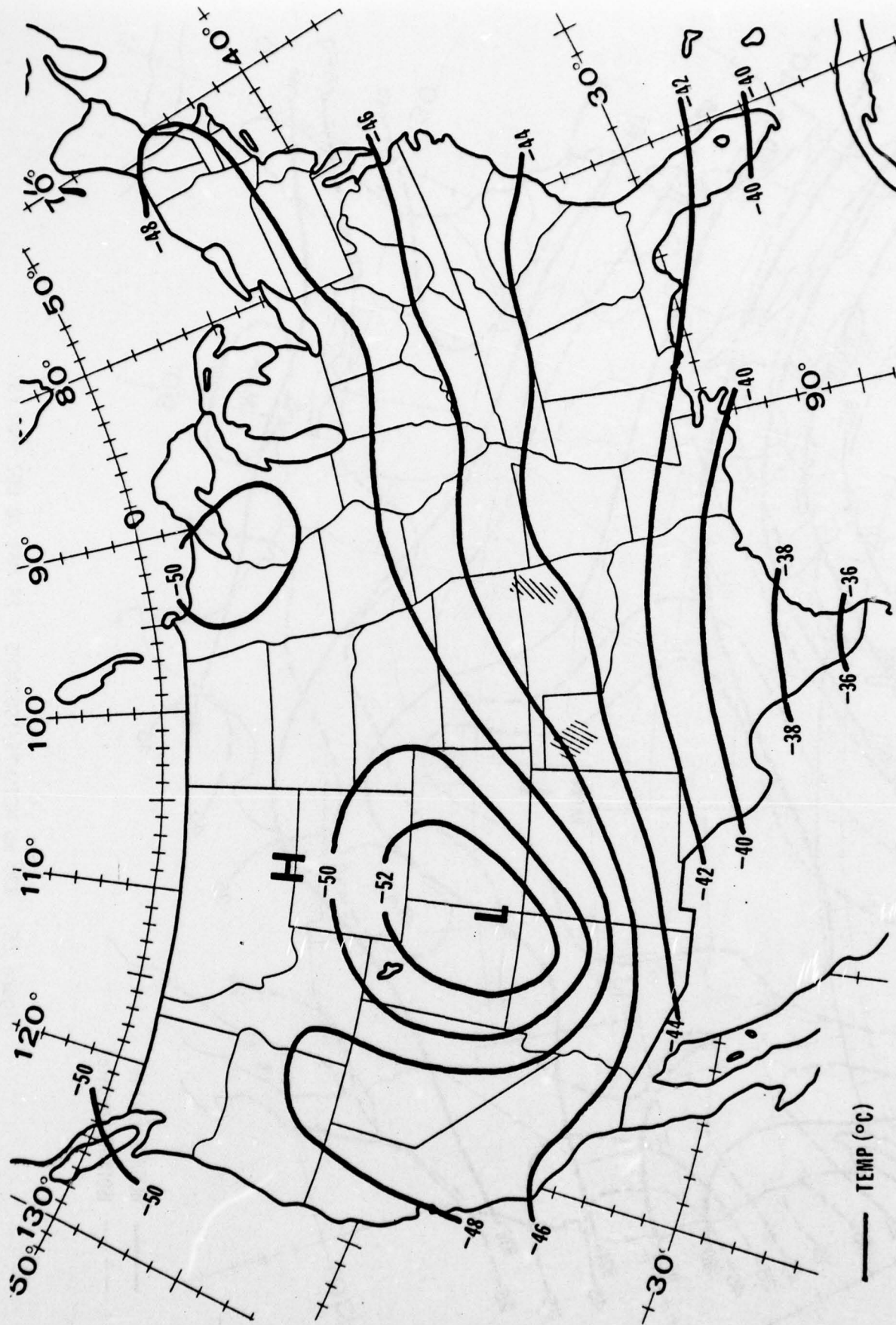


Figure 24. 300 mb TEMPERATURE - 23 MAR 78 12Z ANALYSIS

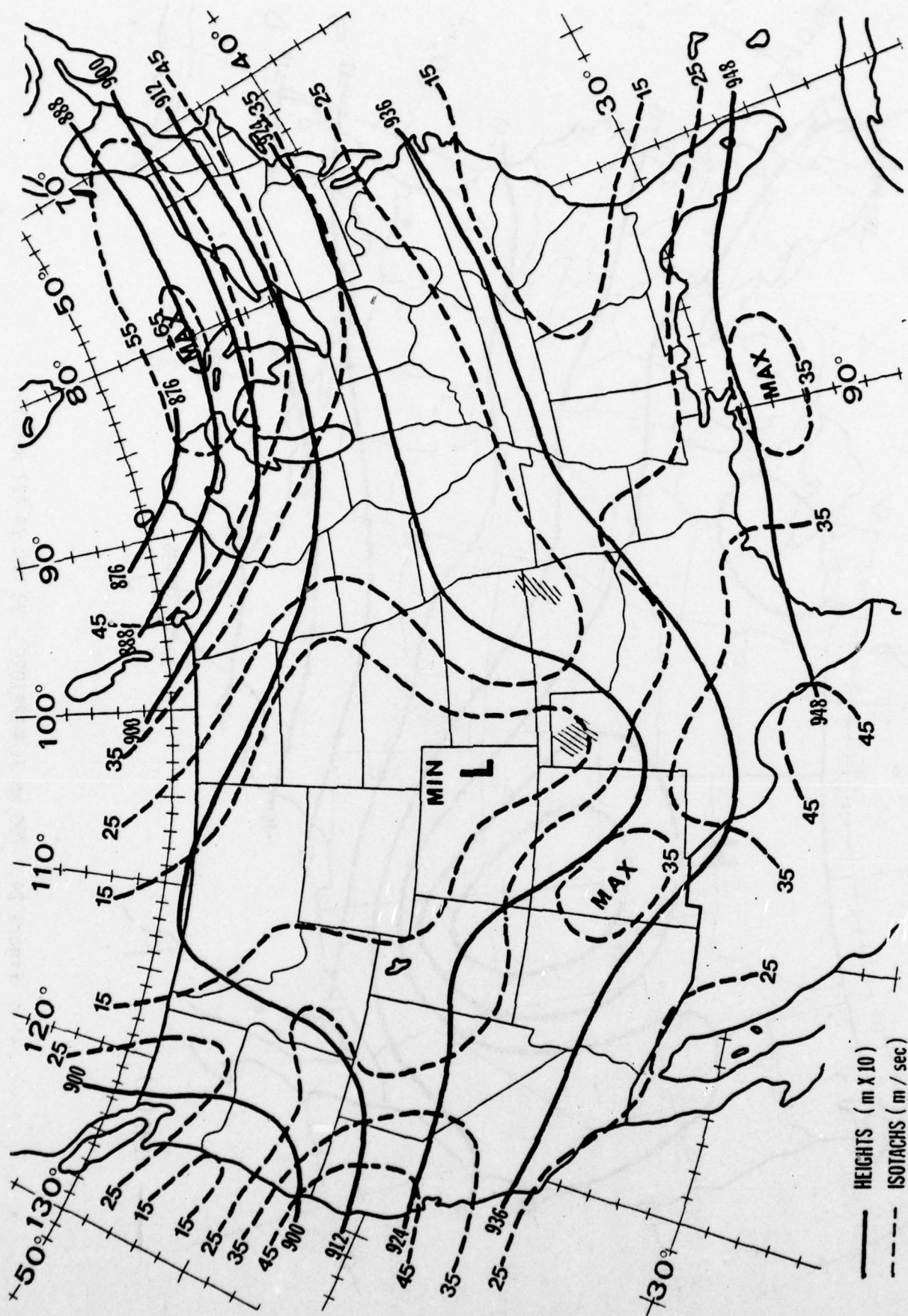


Figure 25. 300 mb HEIGHTS/ISOTACHS - 24 MAR 78 00Z ANALYSIS

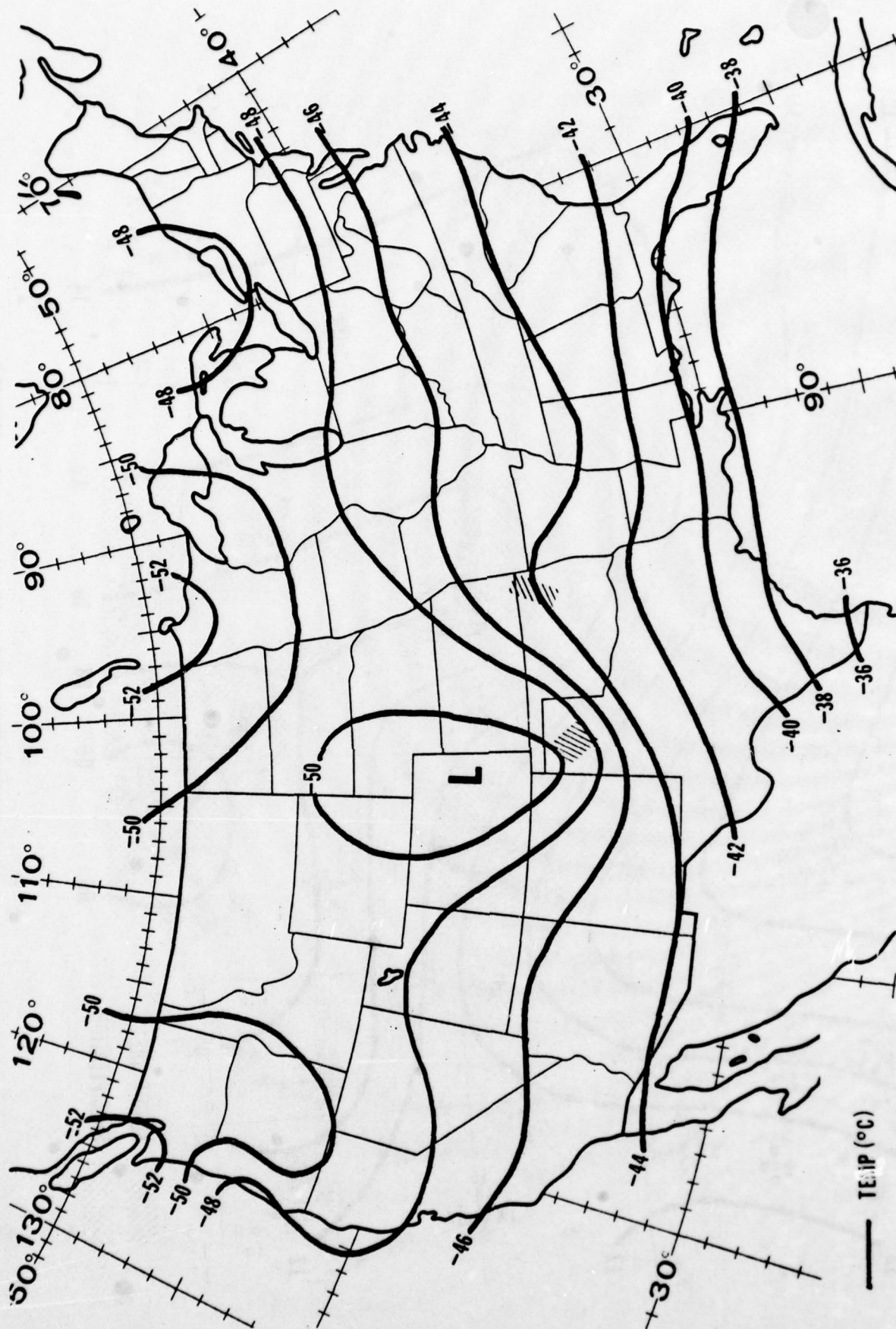
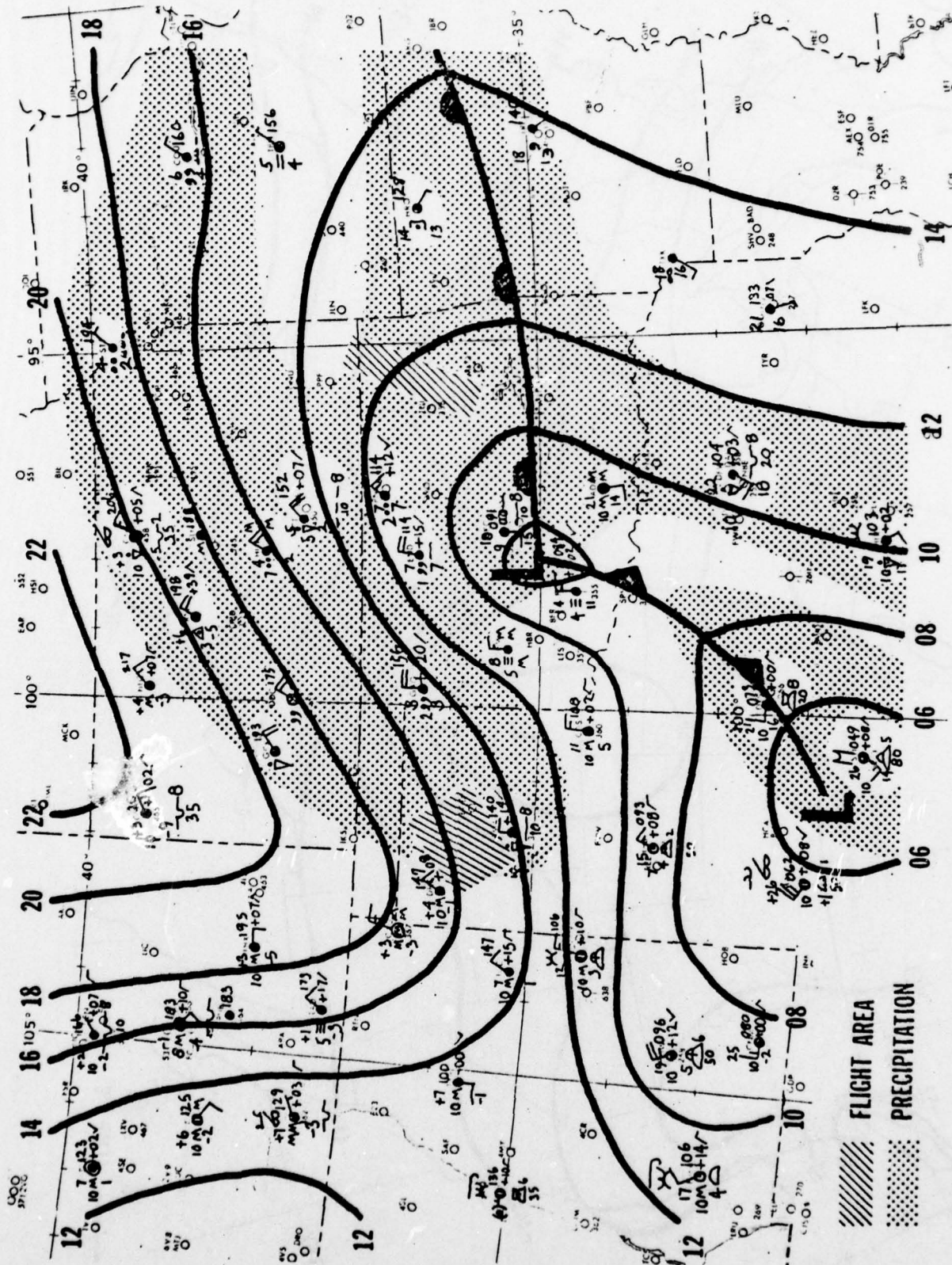


Figure 26. 300 mb TEMPERATURE - 24 MAR 78 00Z ANALYSIS



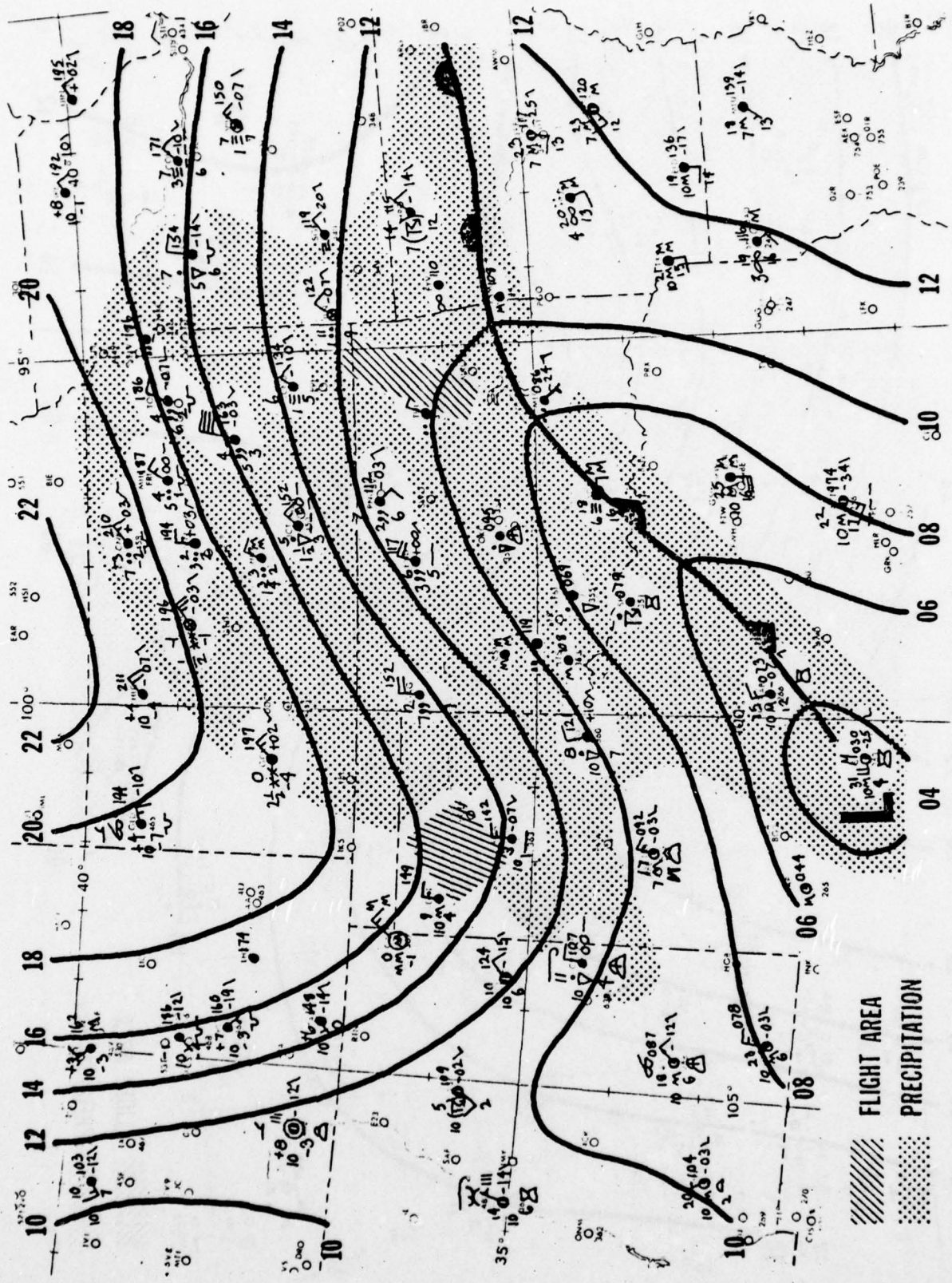


Figure 28. LOCAL SURFACE PRESSURE - 23 MAR 78 21Z ANALYSIS

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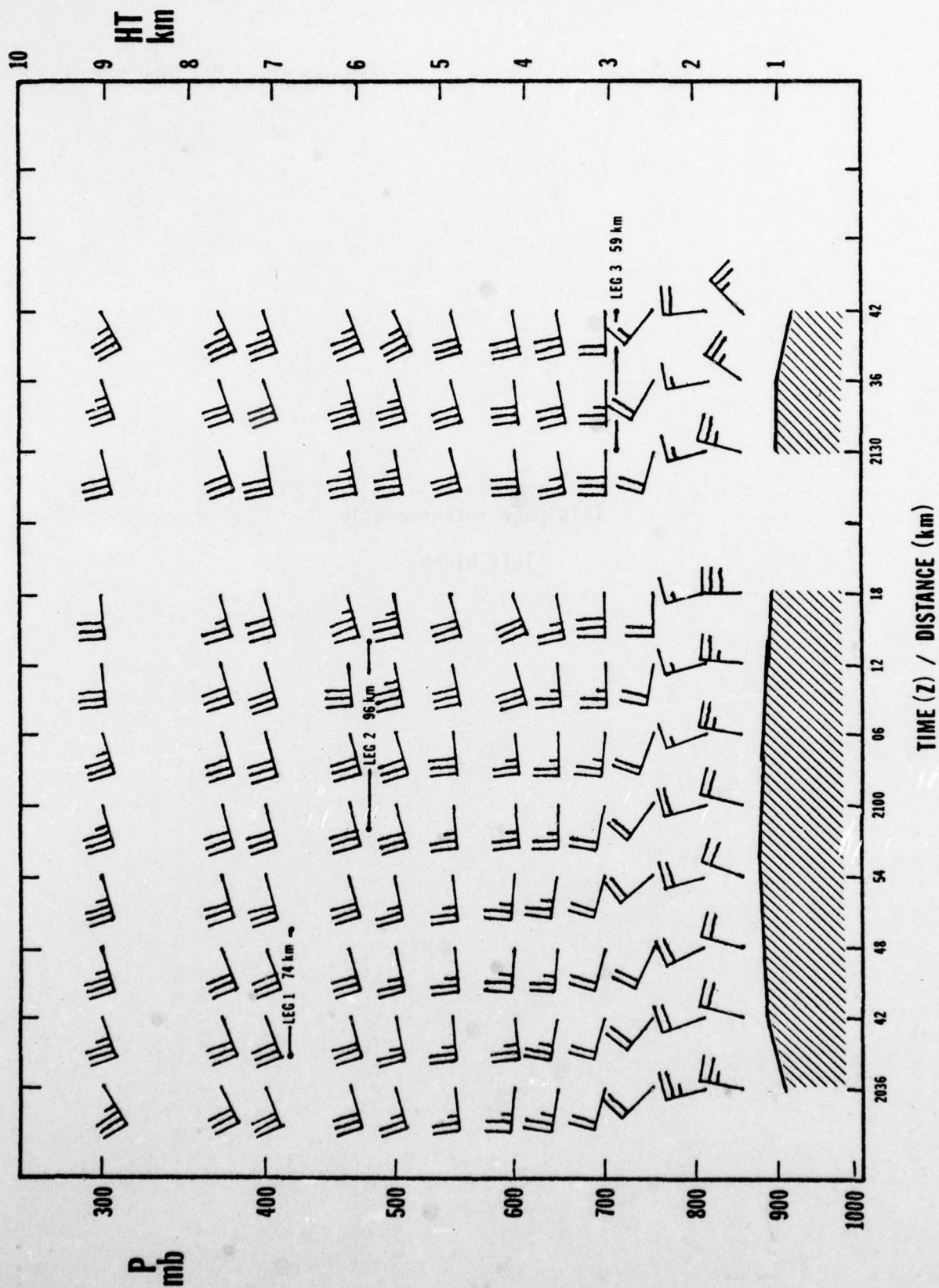


Figure 30. WIND CROSS-SECTION LEGS 1, 2 AND 3 - 23 MAR 78 ANALYSIS

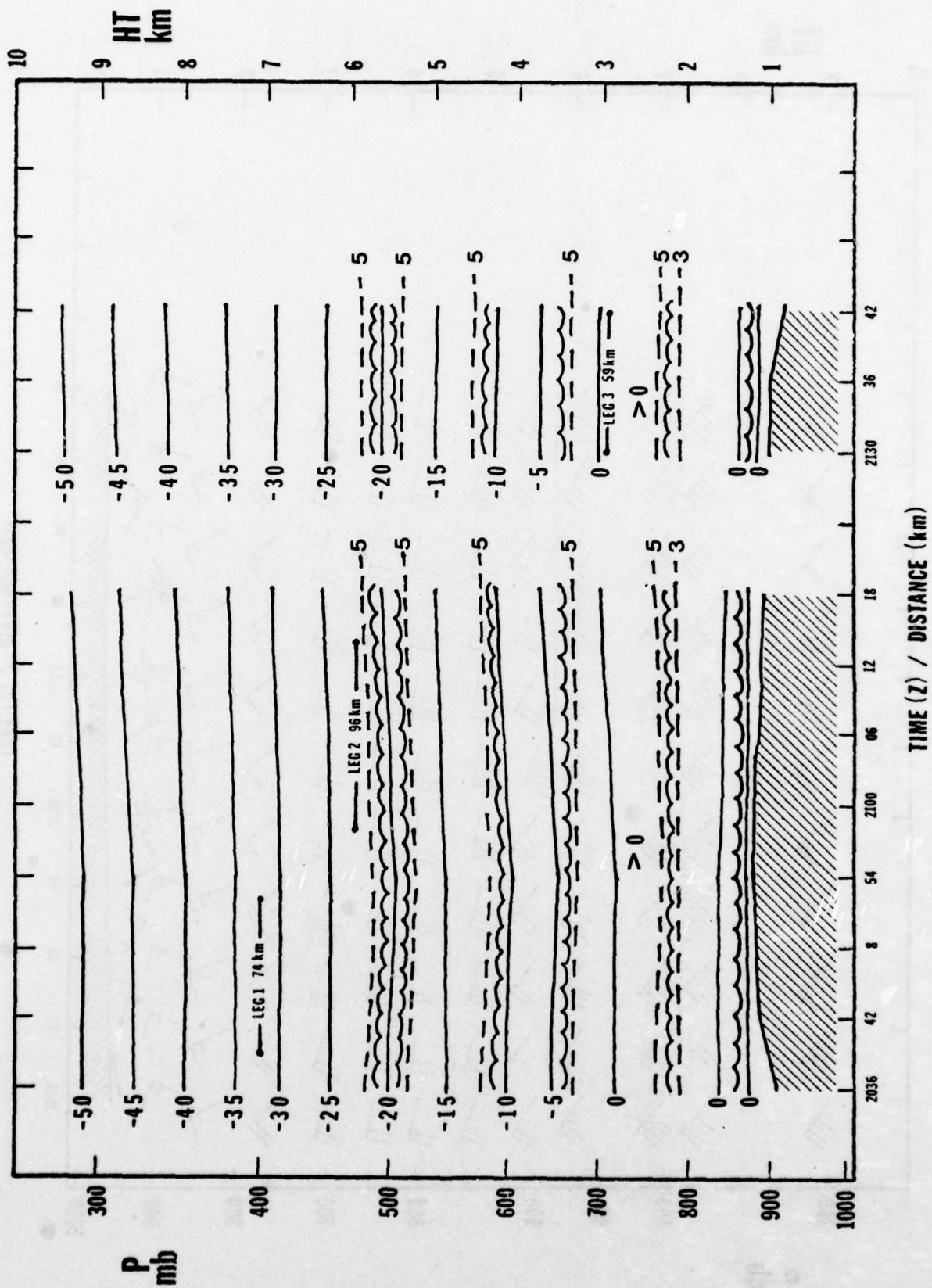


Figure 31. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 1, 2, AND 3 - 23 MAR 78 ANALYSIS

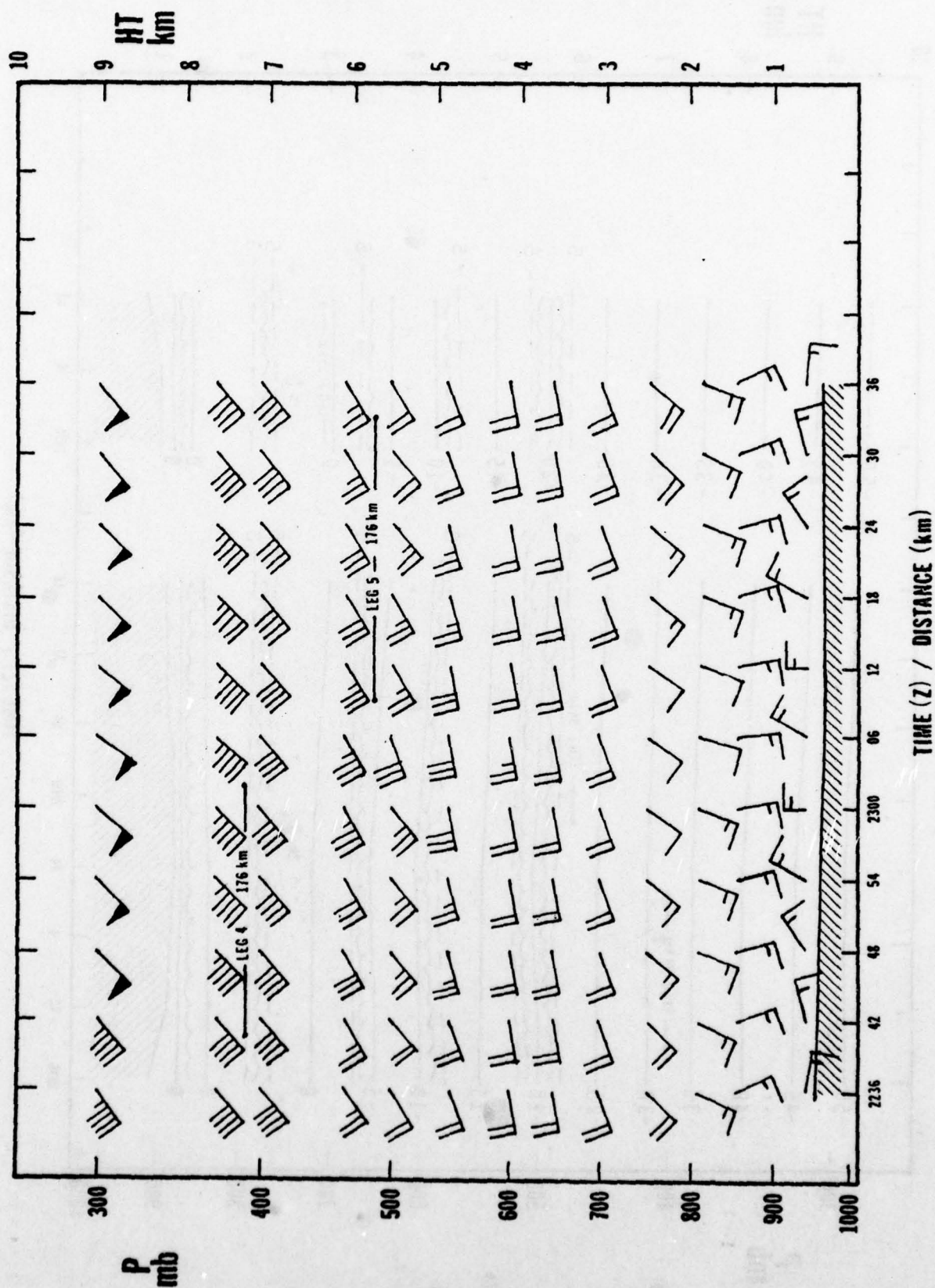


Figure 32. WIND CROSS-SECTION LEGS 4 AND 5 - 23 MAR 78 ANALYSIS

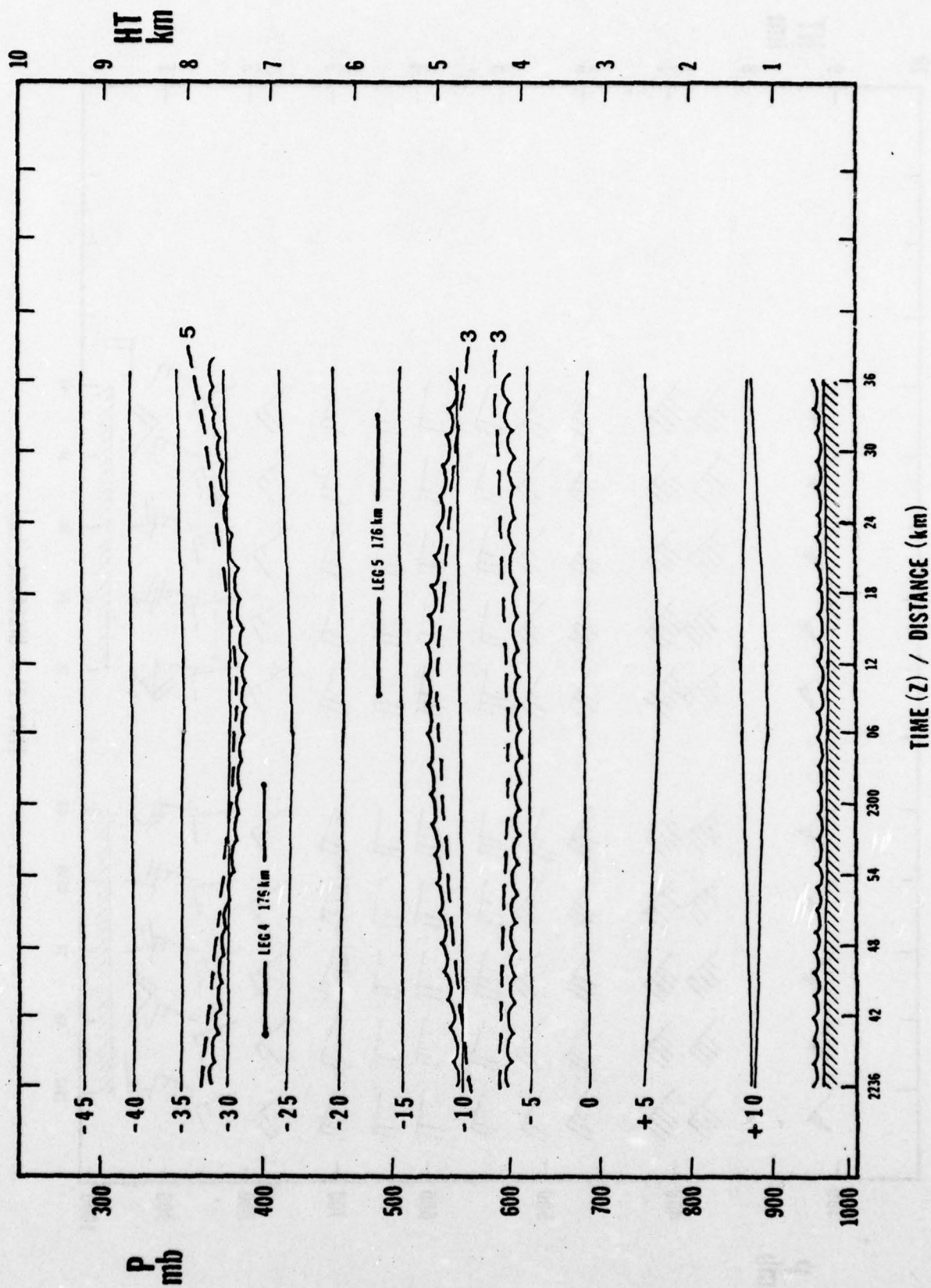
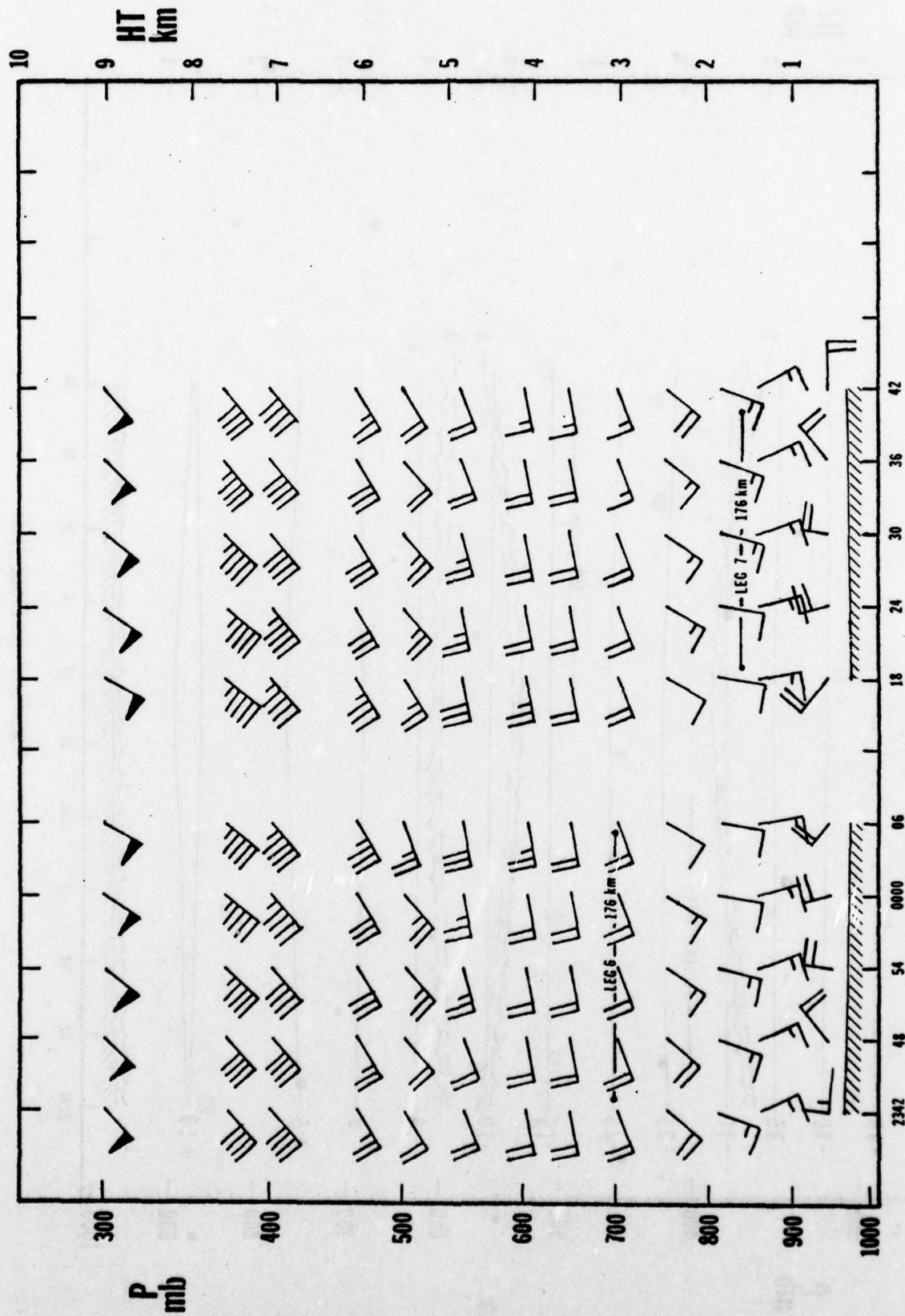


Figure 33. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 4 AND 5 - 23 MAR 78 ANALYSIS



TIME (Z) / DISTANCE (km)

Figure 34. WIND CROSS-SECTION LEGS 6 AND 7 - 23 MAR 78 ANALYSIS

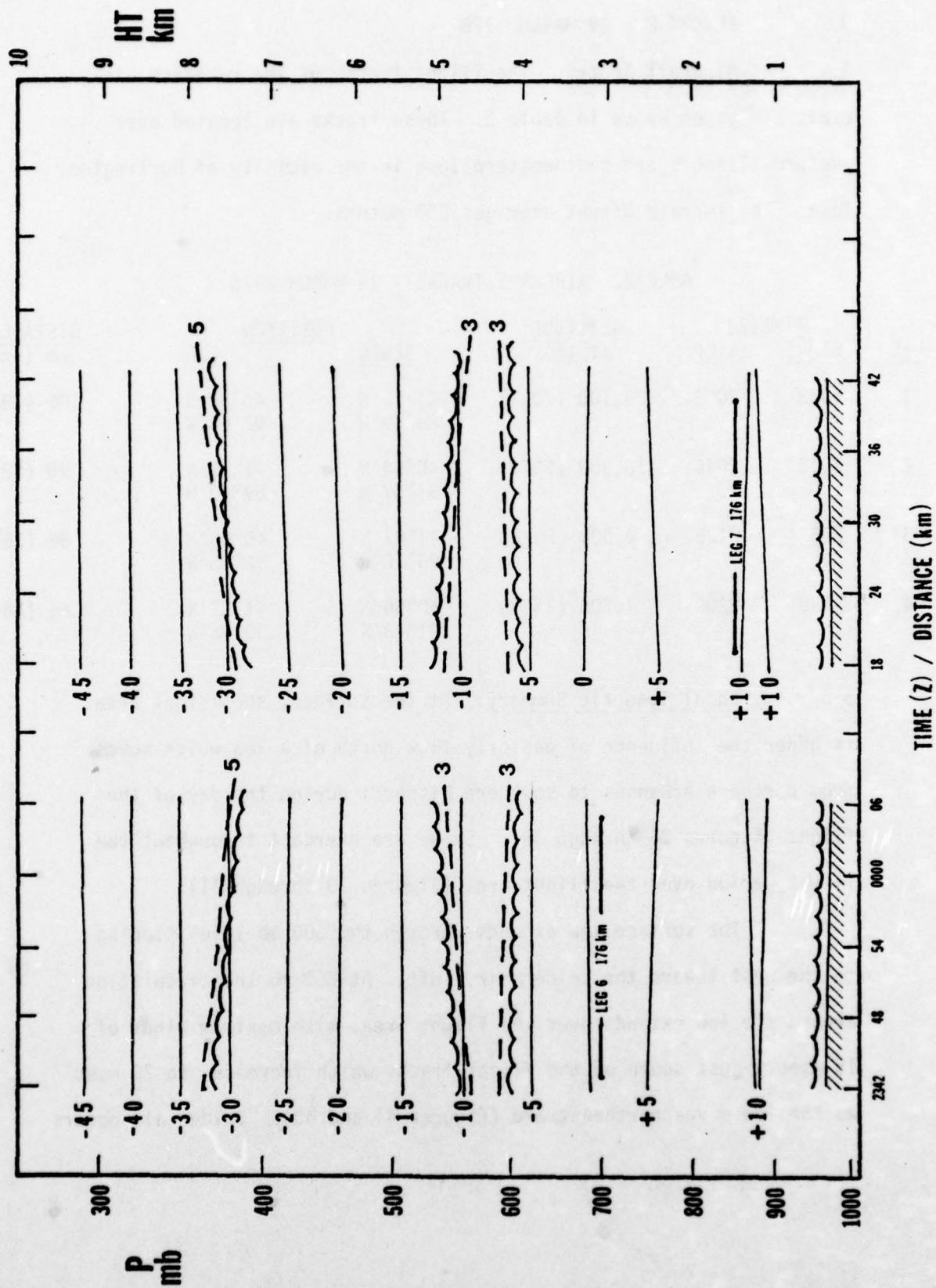


Figure 35. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 6 AND 7 - 23 MAR 78 ANALYSIS

3. FLIGHT 2 24 MARCH 1978

3.1 Aircraft Tracks. The flight tracks of the research aircraft are given below in Table 2. These tracks are located over western Illinois and southeastern Iowa in the vicinity of Burlington, Iowa. The terrain height averages 230 meters.

TABLE 2. AIRCRAFT TRACKS - 24 MARCH 1978

LEG	TIME(Z)		ALTITUDE ft (m)	POSITION		DISTANCE nm (km)
	START	STOP		BEGIN	END	
1	1943	2007	23,100 (7041)	41°10'N 89°40'W	40°50'N 92°00'W	106 (196)
2	2015	2046	18,300 (5578)	40°54'N 91°57'W	41°10'N 89°43'W	98 (181)
3	2057	2125	9,600 (2926)	41°07'N 90°10'W	40°50'N 92°05'W	88 (163)
4	2136	2200	4,700 (1433)	40°56'N 91°48'W	41°01'N 90°48'W	46 (85)

3.2 Local Synoptic Summary. At the surface, the flight area is under the influence of easterly flow north of a low which moves from northern Arkansas to southern Missouri during the day of the flight (Figures 36 through 38). Skies are overcast throughout the flight period over the flight area (Figures 39 through 41).

The surface low extends through the 300 mb level sloping to the west toward the colder air aloft. At 850 mb the circulation around the low extends over the flight area, with maximum winds of 15 msec^{-1} just south of the flight tracks which increase to 20 msec^{-1} as the low moves northeastward (Figures 41 and 43). Colder air occurs

west of the low with a broad region of moisture surrounding the low at 850 mb (Figure 42). Temperatures increase slightly as the area of moisture moves over the flight region (Figure 43).

The 700 mb level low southwest of the flight area intensifies as it moves slowly eastward. An isotach maximum south of the low increases in magnitude from 20 to 25 msec^{-1} (Figures 46 and 48). The temperature and high moisture level change little at 700 mb over the flight area (Figures 47 and 49).

At 500 mb the low southwest of the flight area moves slowly eastward and deepens. Winds over the flight zone remain near 10 msec^{-1} throughout the day of the flight (Figures 50 and 52). An area of moist air associated with the low at 500 mb extends over the flight area while the temperatures decrease slightly (Figures 51 and 53). An area of upward moving air centered south of and extending over the flight region moves eastward. Positive vorticity associated with the low is advected toward the flight area (Figures 54 and 55).

At the 300 mb level the trough lies to the southwest of the flight area and moves eastward. Winds diminish over the flight area at this level with the approaching trough (Figures 56 and 58). Temperatures remain constant throughout the flight period within the flight area (Figures 57 and 59).

The local surface charts (Figures 60 through 62) show the low and its frontal system located south of the flight area

and moving eastward. Easterly flow prevails over the flight region. A wide band of precipitation extends north of the low and over the flight area during the period of the flight. Frozen precipitation occurs over the flight zone throughout the period of the flight.

The vertical cross-sections (Figures 63 through 66) show the winds to be easterly at low levels veering with altitude and generally decreasing through 600 mb and then increasing slightly through 300 mb. The surface temperature is below freezing and decreases slowly with height to 700 mb where the lapse rate becomes closer to standard. A deep moist layer exists from near the surface to 8 km. The cloud bases average 300 meters above the ground level.

At the beginning of the flight a simple tropopause exists over the flight area at 10.9 km and gradually decreases to 10.7 km during the flight period. Temperatures at the tropopause increase from -59°C at the start of the flight to -57°C by the end of the period.

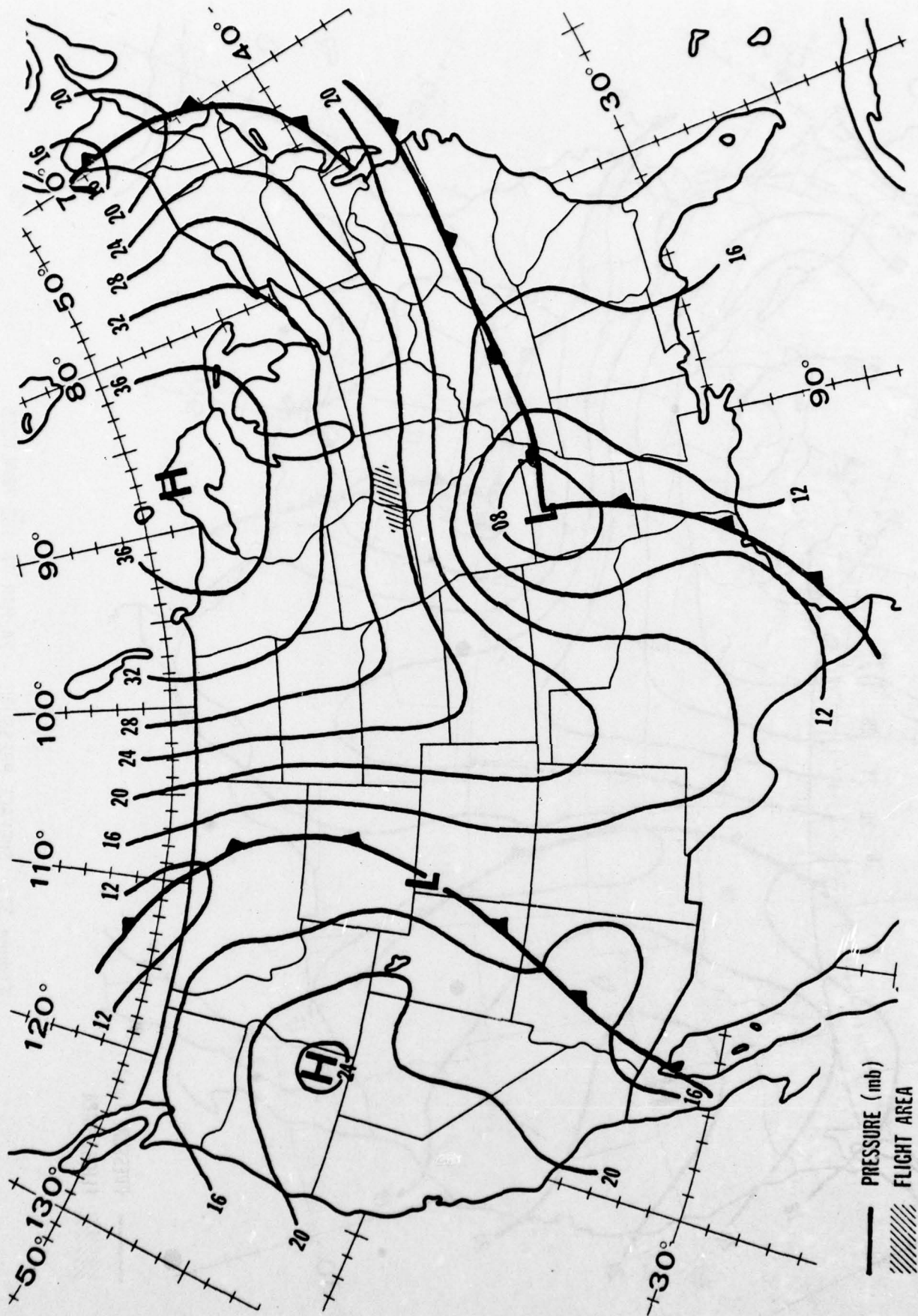


Figure 36. SURFACE PRESSURE - 24 MAR 78 12Z ANALYSIS

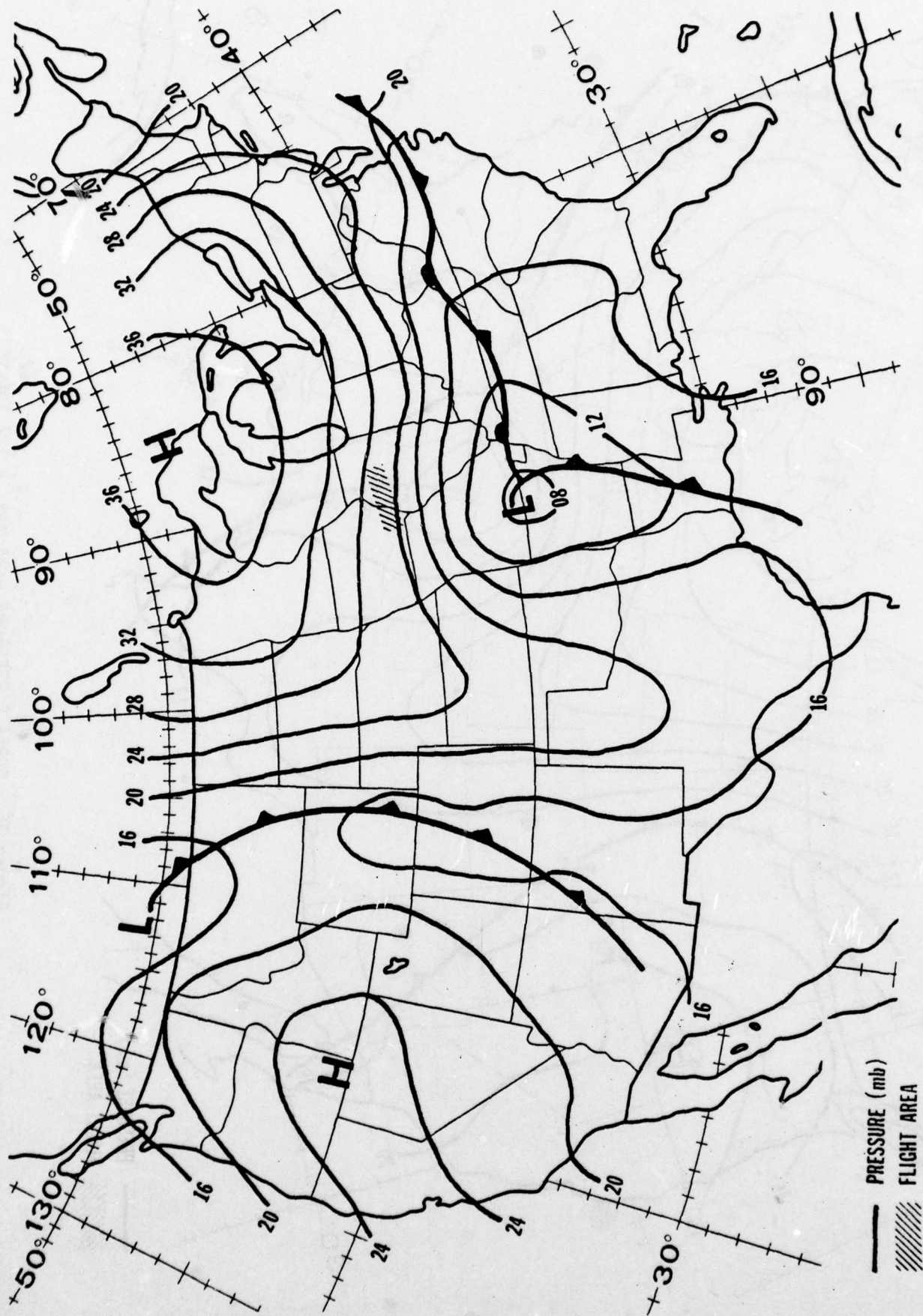


Figure 37. SURFACE PRESSURE - 24 MAR 78 18Z ANALYSIS

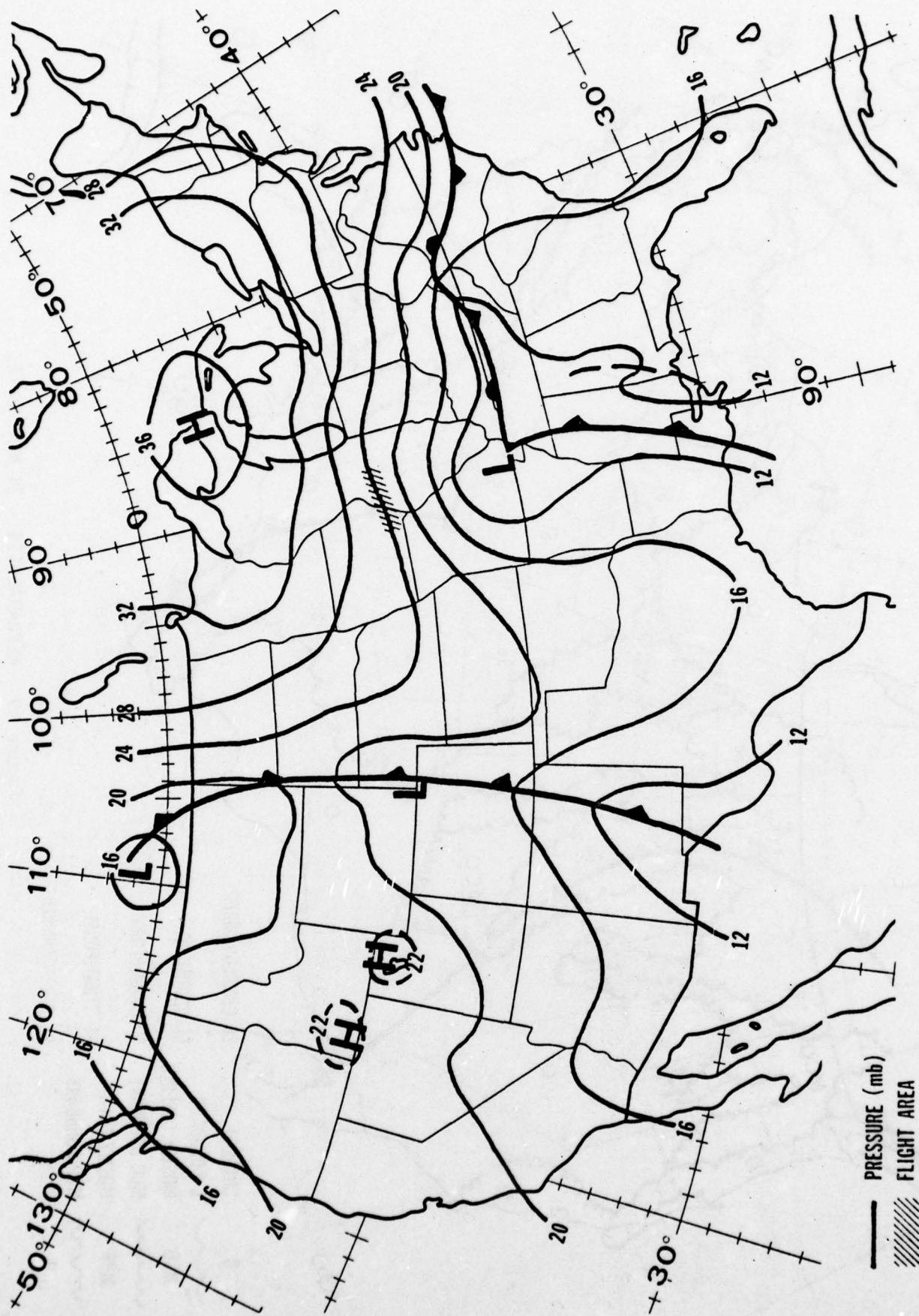


Figure 38. SURFACE PRESSURE - 25 MAR 78 00Z ANALYSIS

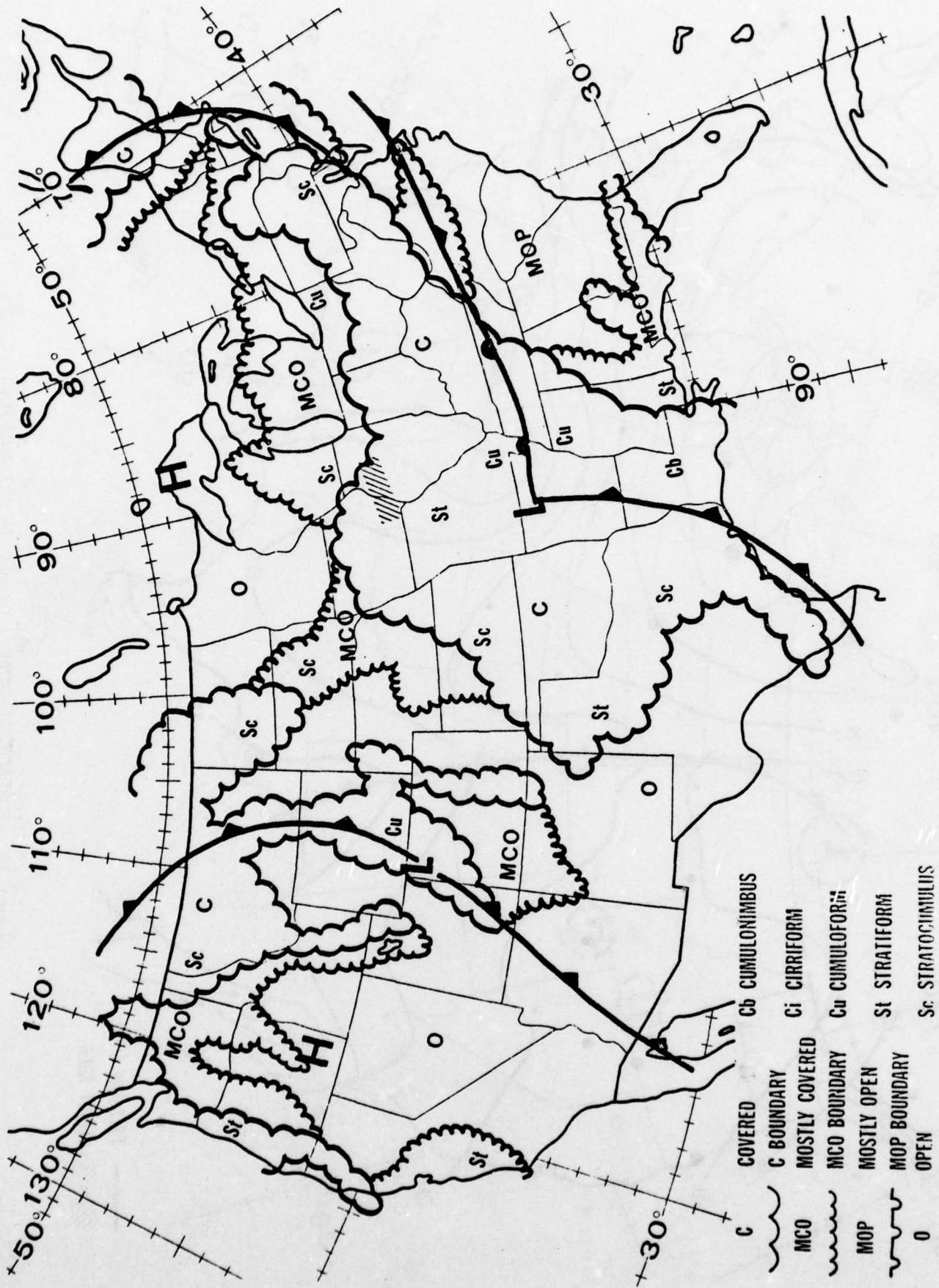


Figure 39. NEPHANALYSIS - 24 MAR 78 12Z

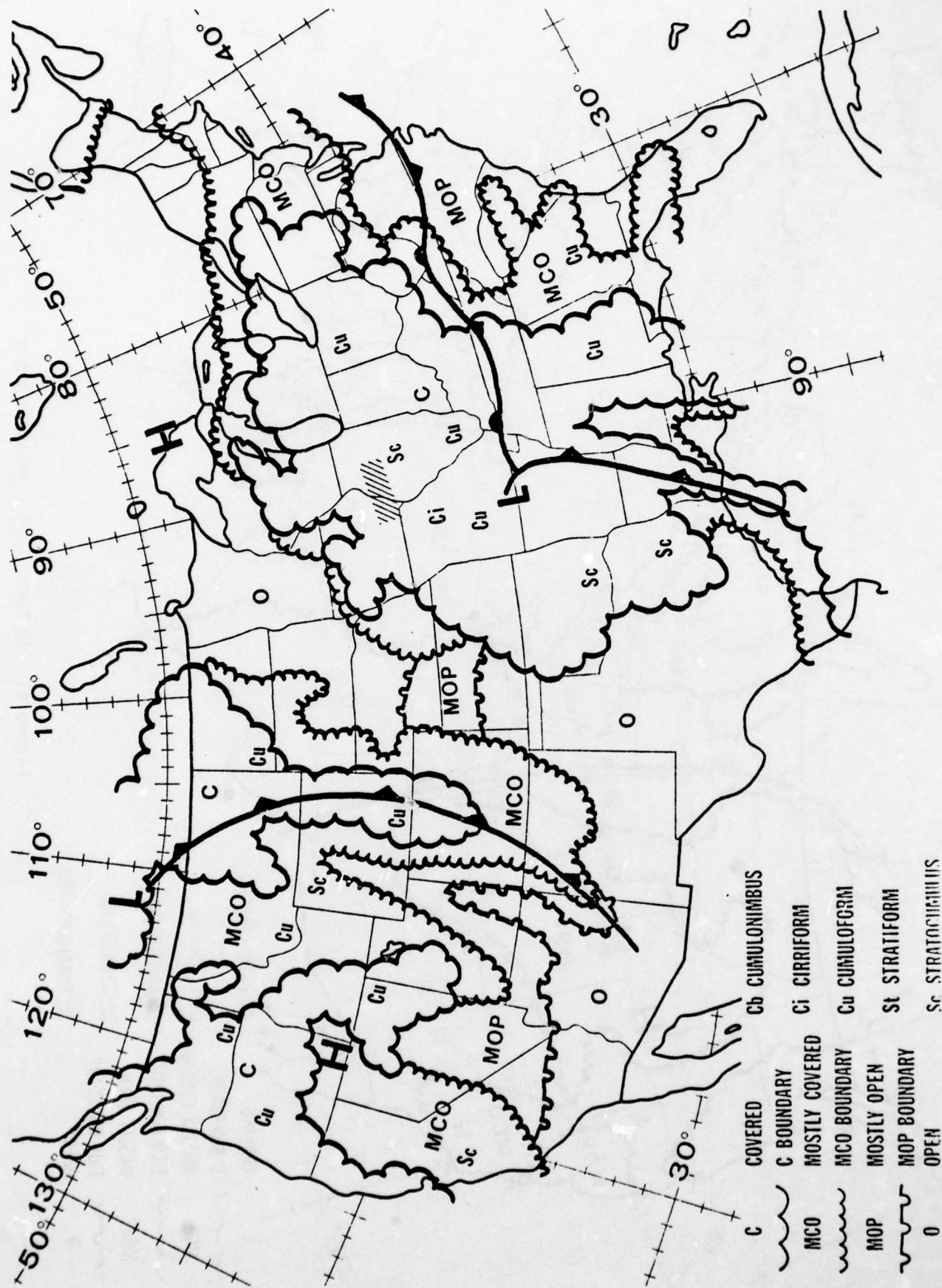


Figure 40. NEPHANALYSIS - 24 MAR 78 18Z

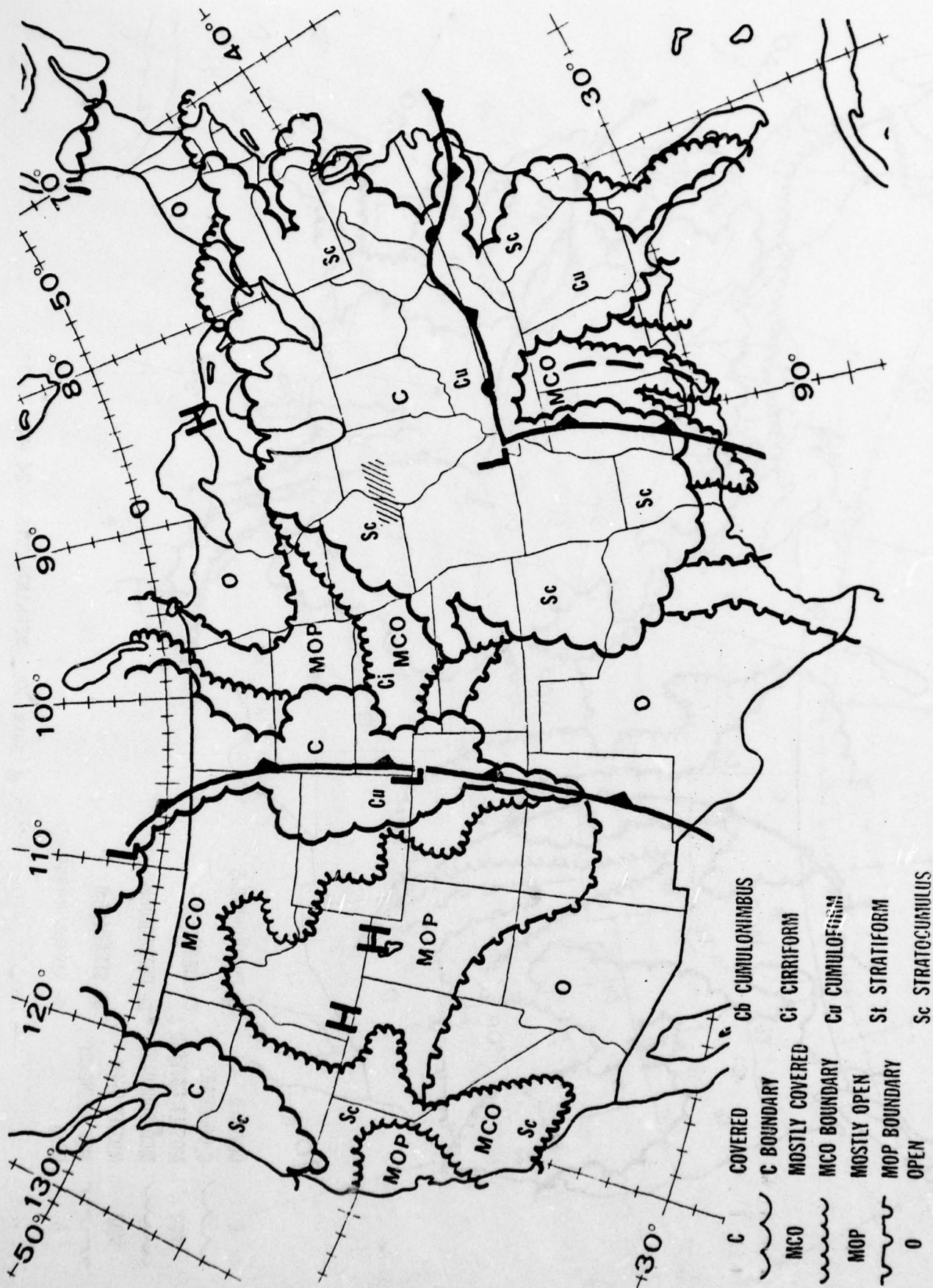


Figure 41. NEPHANALYSIS - 25 MAR 78 00Z

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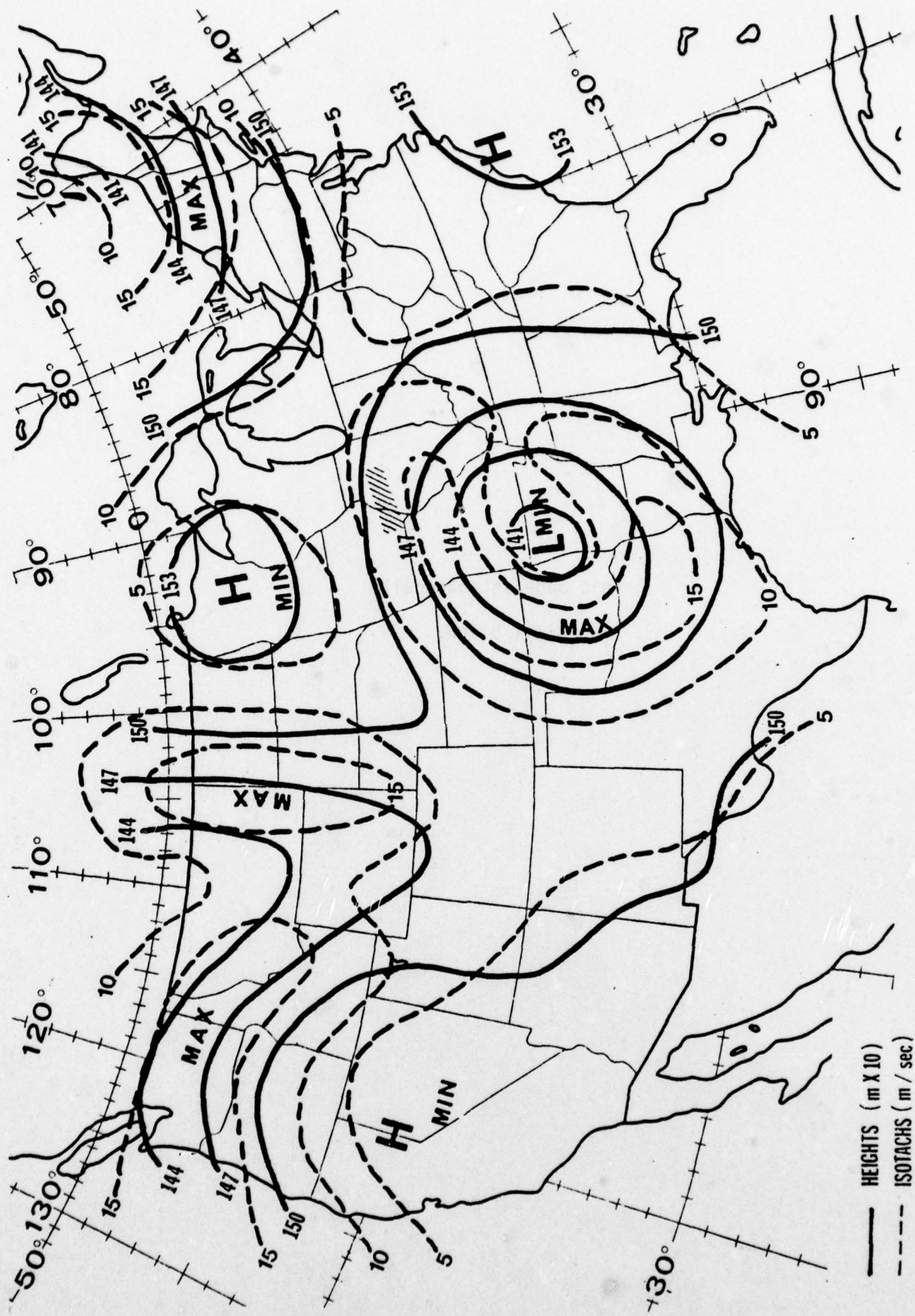


Figure 42. 850 mb HEIGHTS/ISOTACHS - 24 MAR 78 12Z ANALYSIS

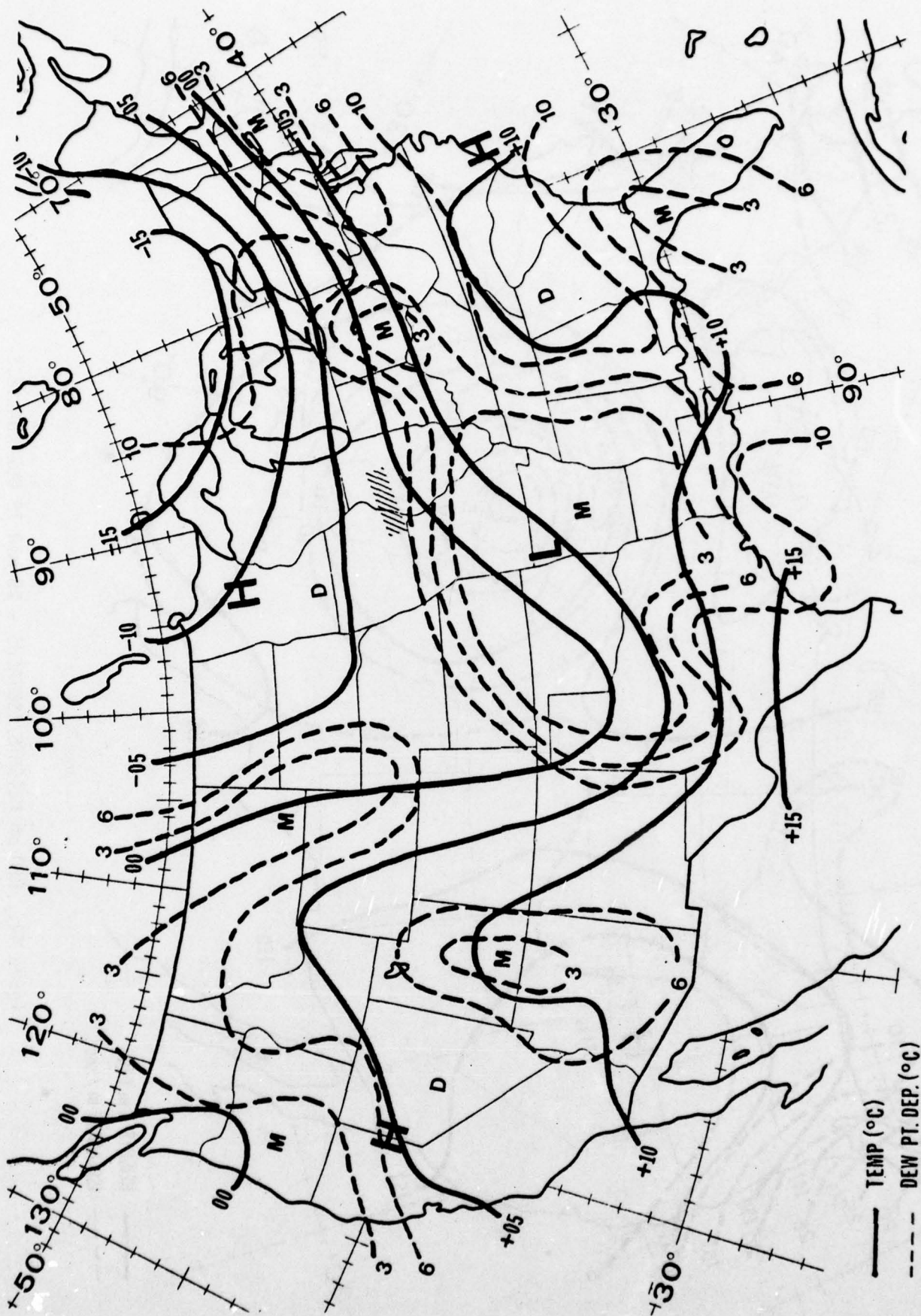


Figure 43. 850 mb TEMP./DEW PT. DEPRESSION - 24 MAR 78 12Z ANALYSIS

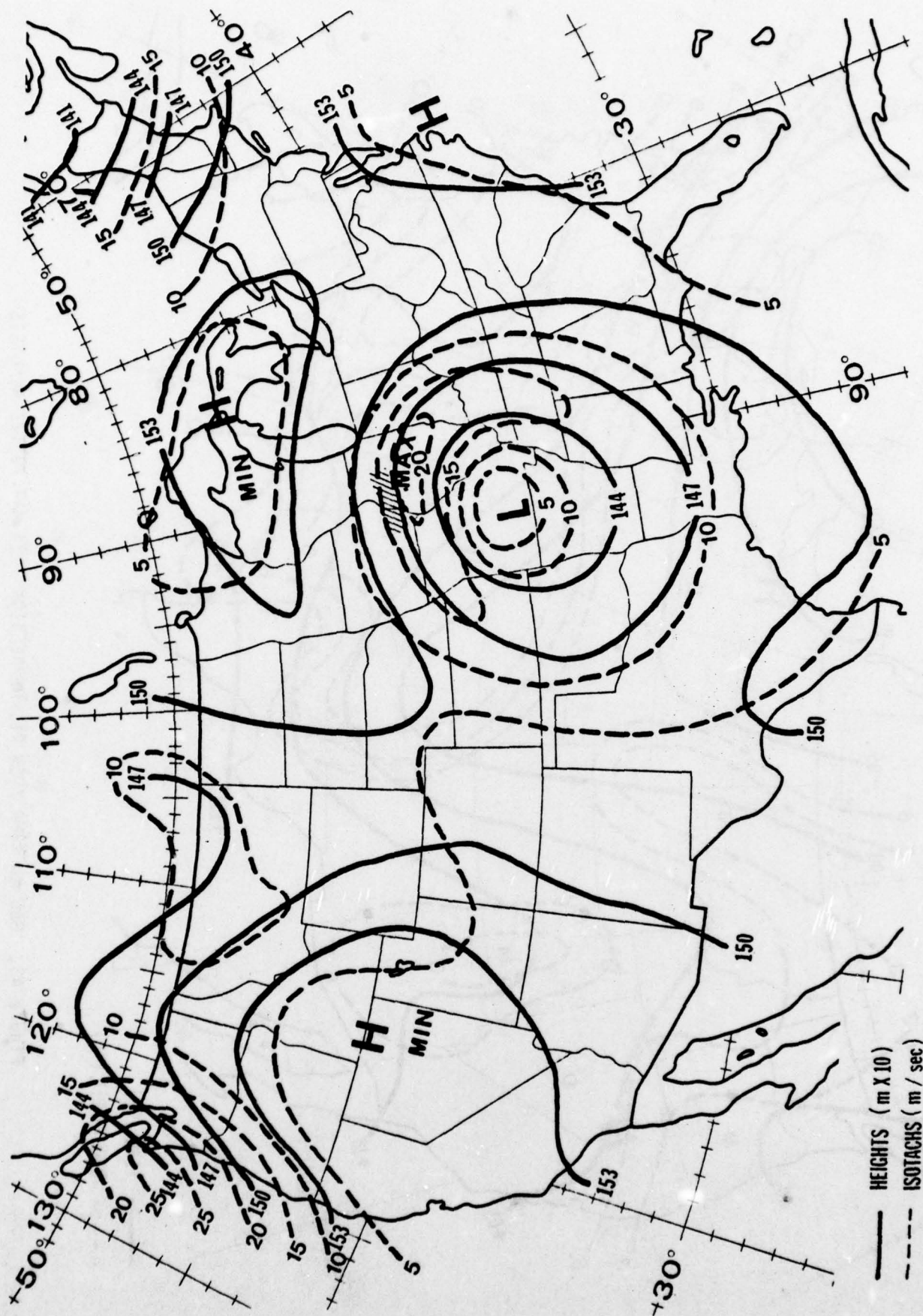


Figure 44. 850 mb HEIGHTS/ISOTACHS - 25 MAR 78 00Z ANALYSIS

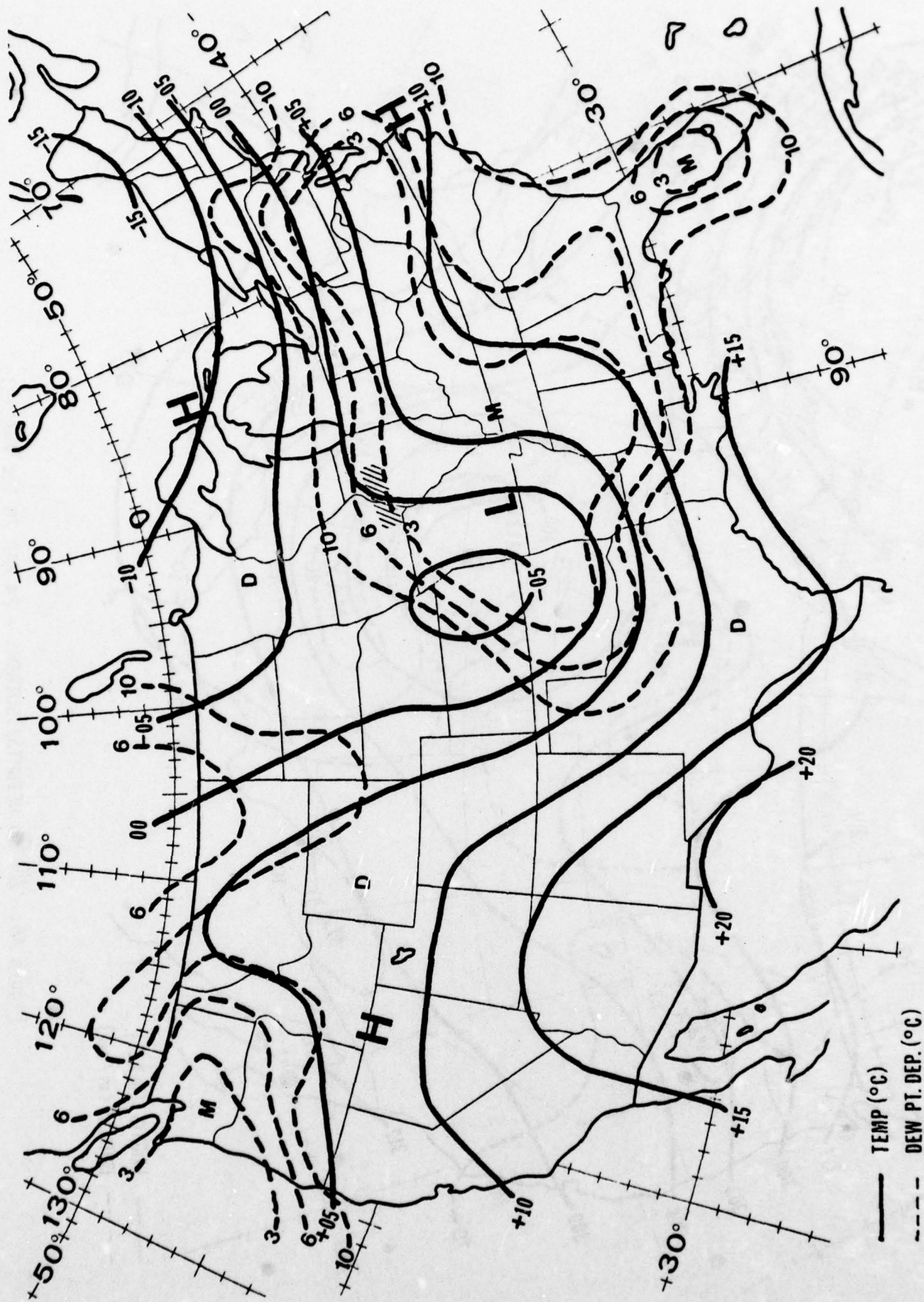


Figure 45. 850 mb TEMP./DEW PT. DEPRESSION - 25 MAR 78 00Z ANALYSIS

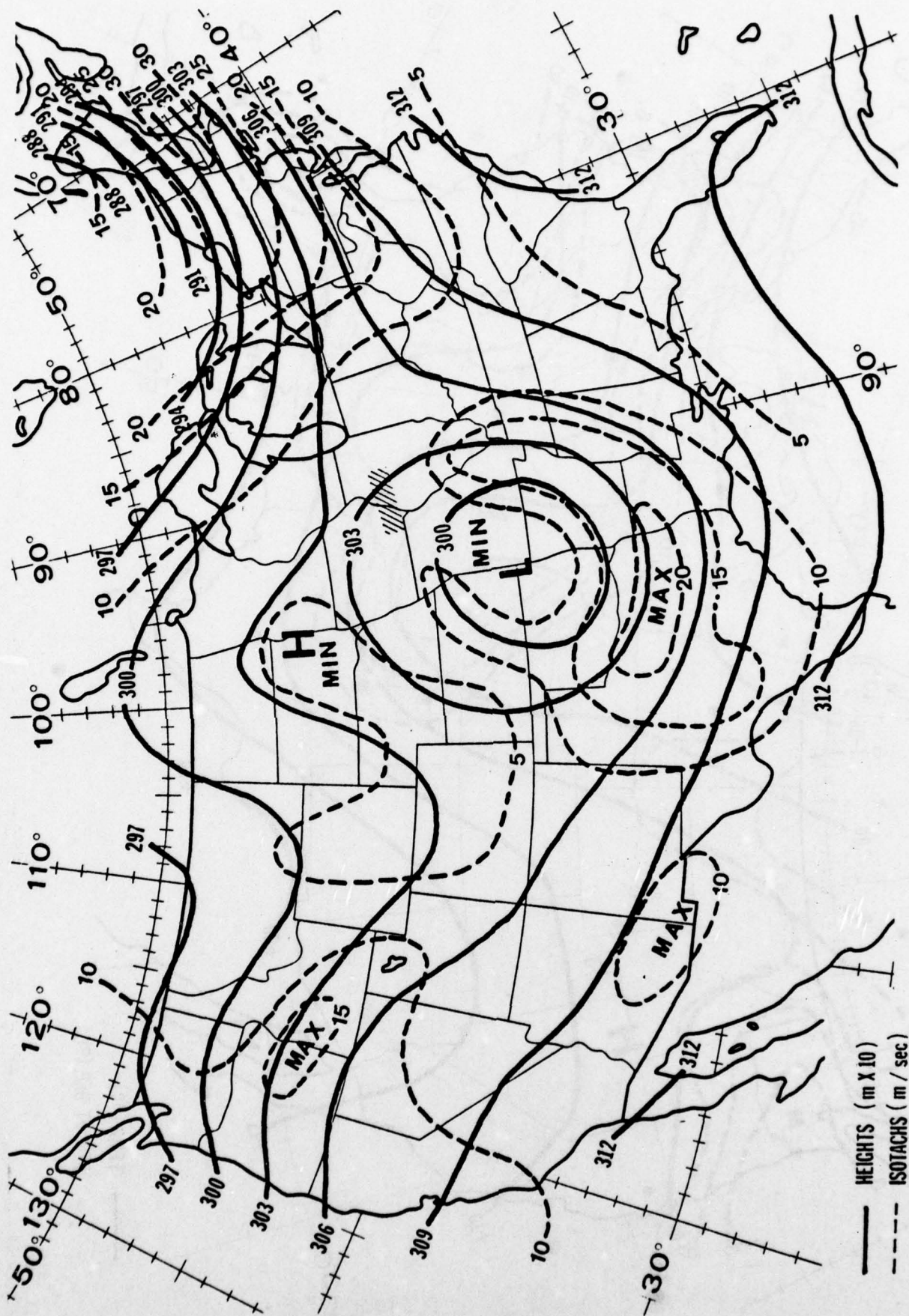


Figure 46. 700 mb HEIGHTS/ISOTACHS - 24 MAR 78 12Z ANALYSIS

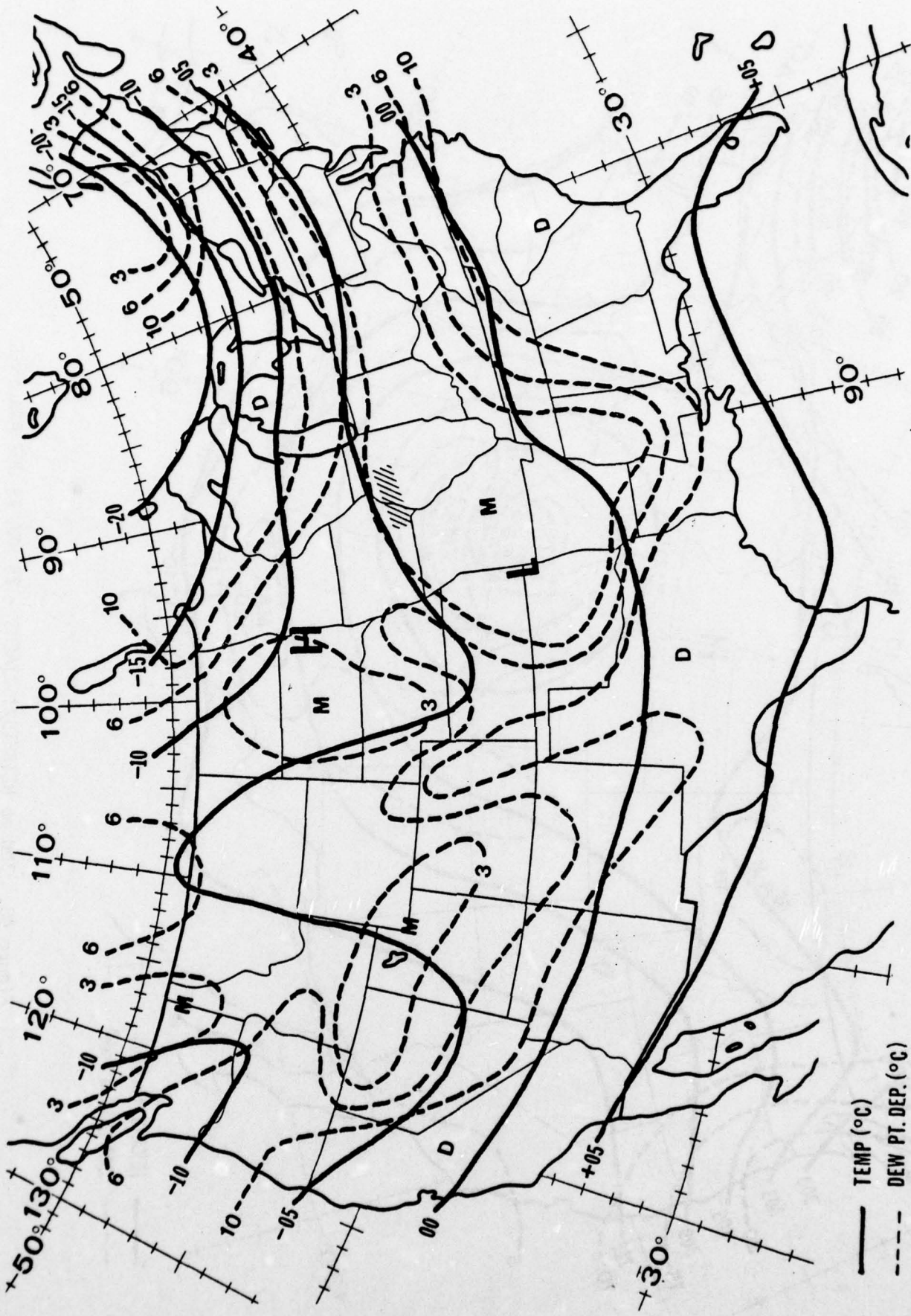


Figure 47. 700 mb TEMP./DEW PT. DEPRESSION - 24 MAR 78 12Z ANALYSIS

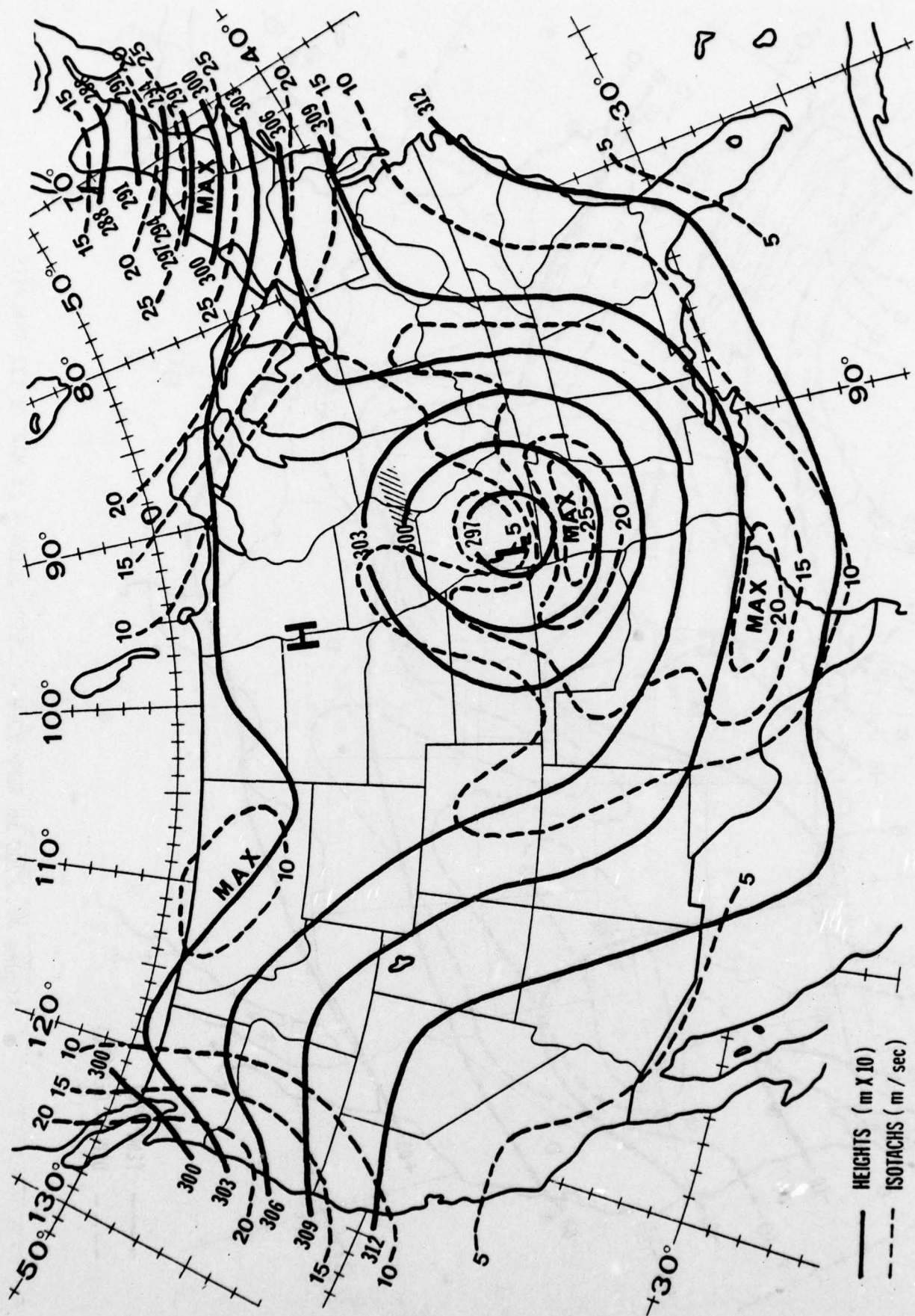


Figure 48. 700 mb HEIGHTS/ISOTACHS - 25 MAR 78 00Z ANALYSIS

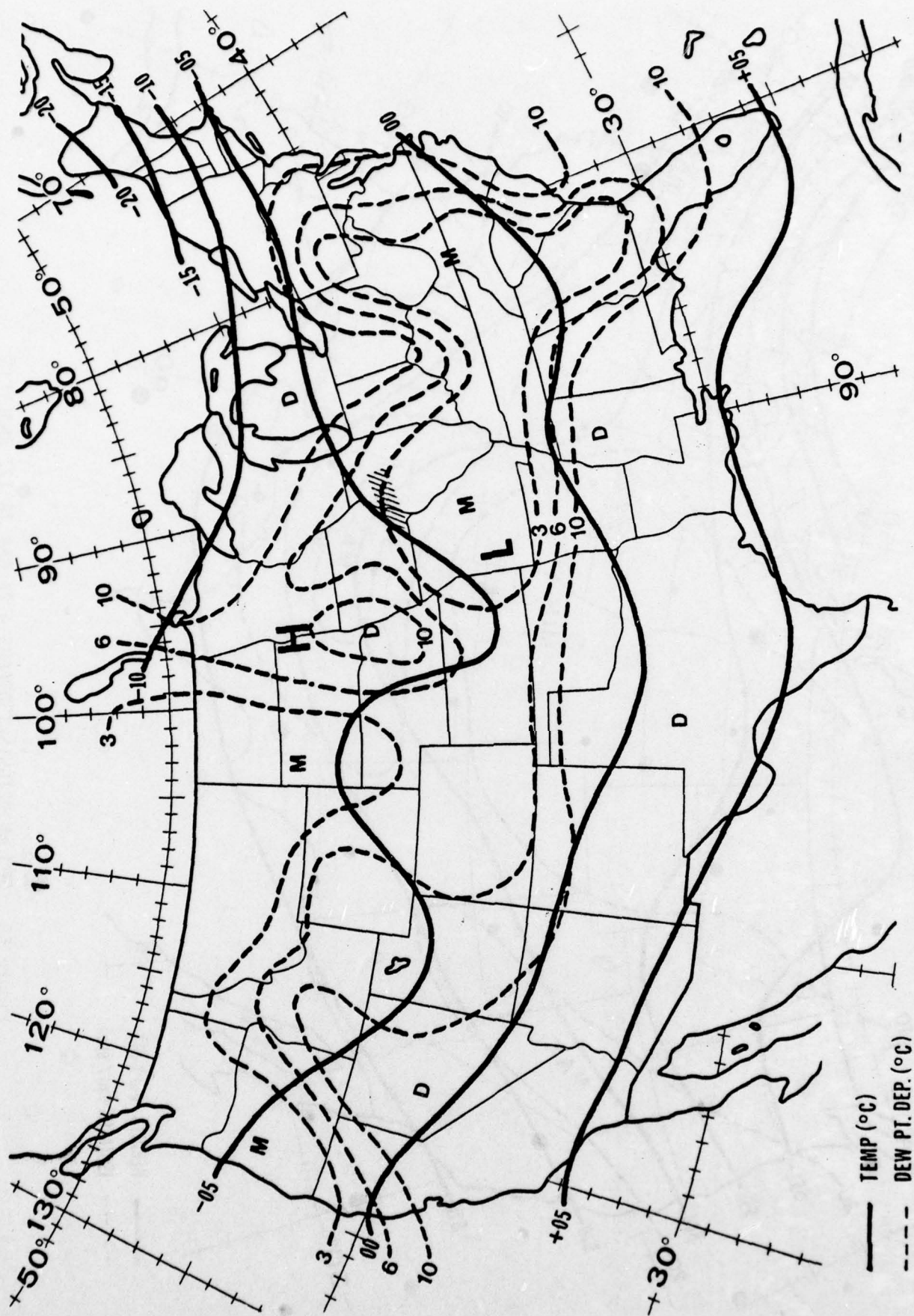


Figure 49. 700 mb TEMP./DEW PT. DEPRESSION - 25 MAR 78 00Z ANALYSIS

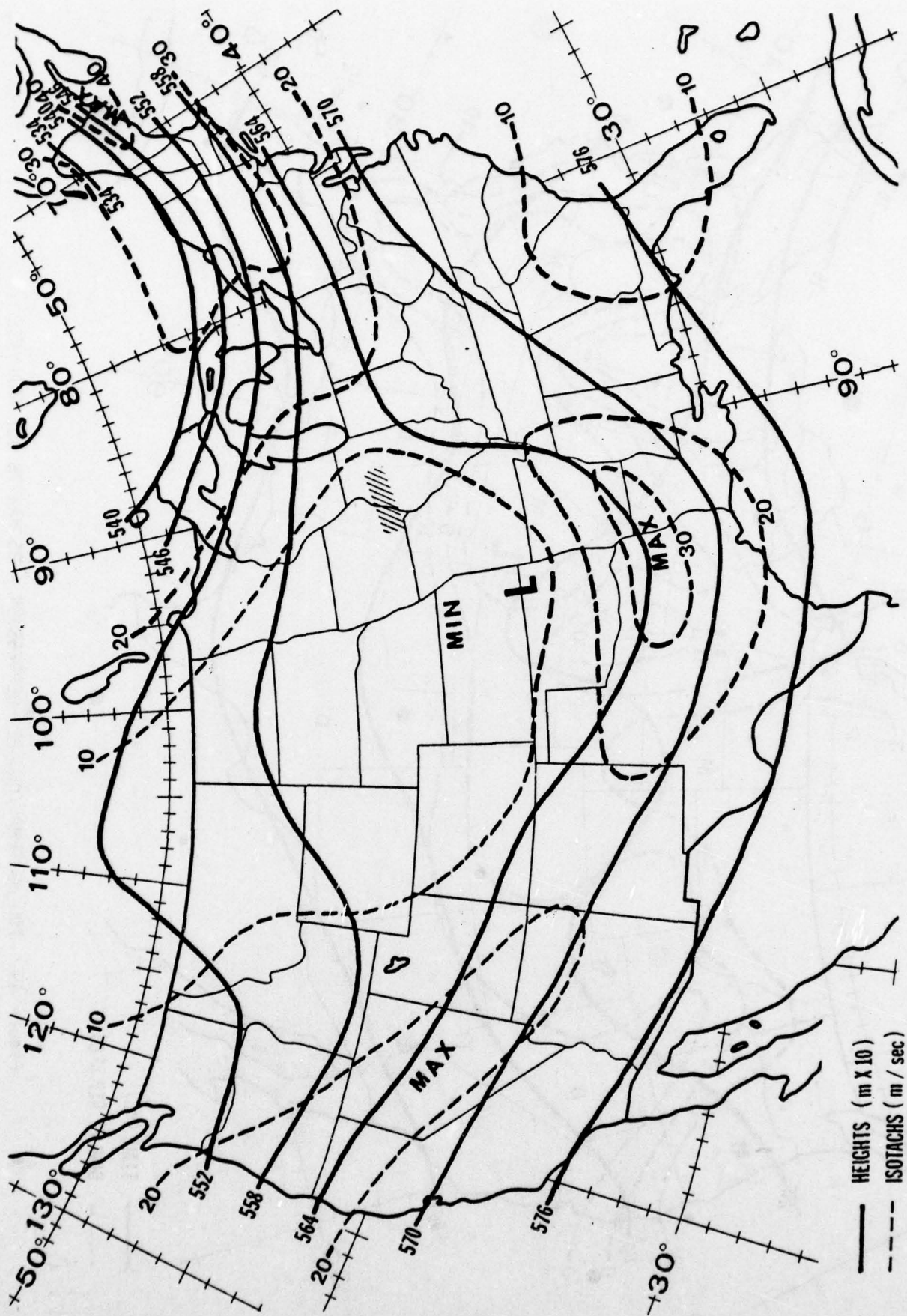


Figure 50. 500 mb HEIGHTS/ISOTACHS - 24 MAR 78 12Z ANALYSIS

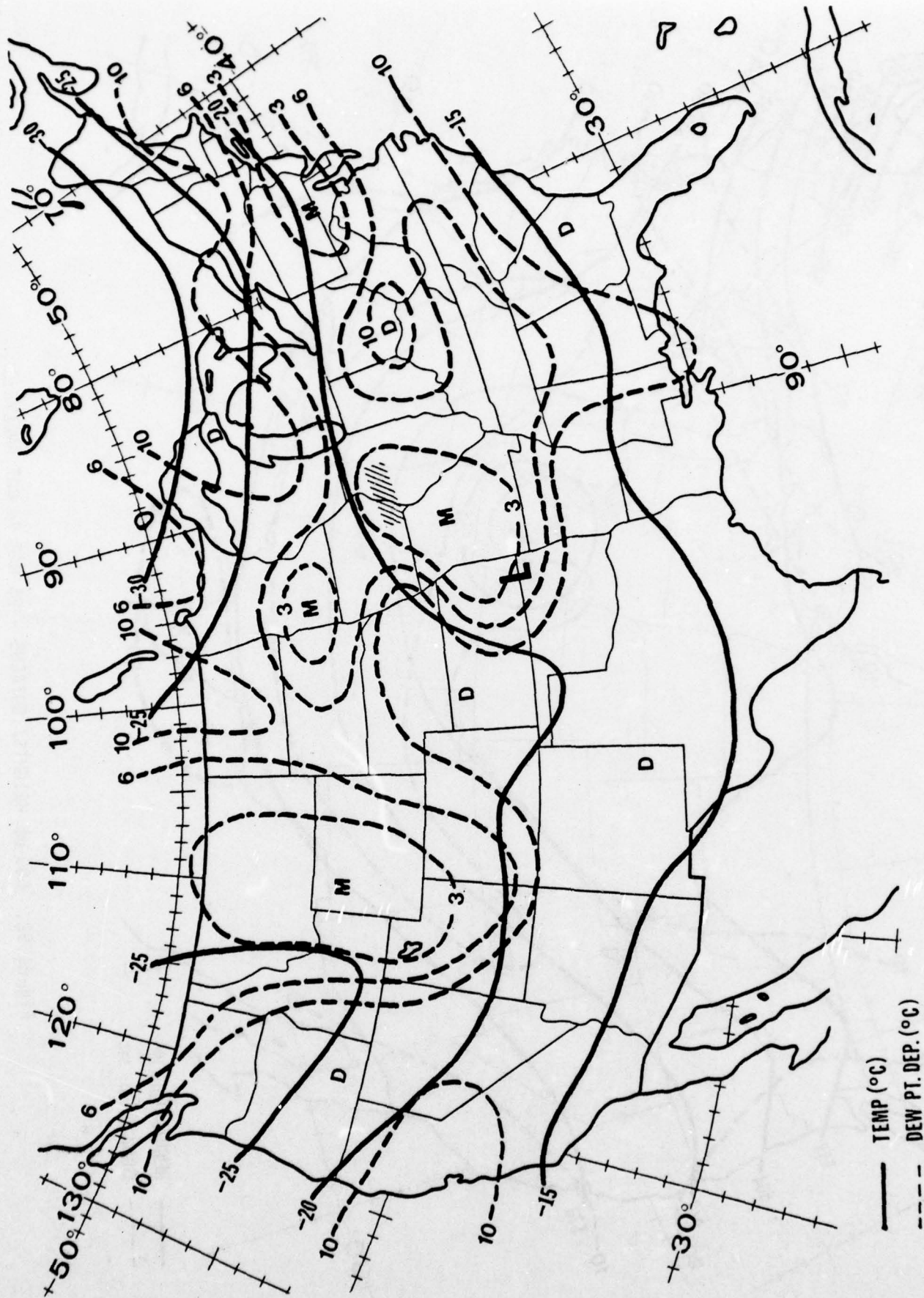


Figure 51. 500 mb TEMP./DEW PT. DEPRESSION - 24 MAR 78 12Z ANALYSIS

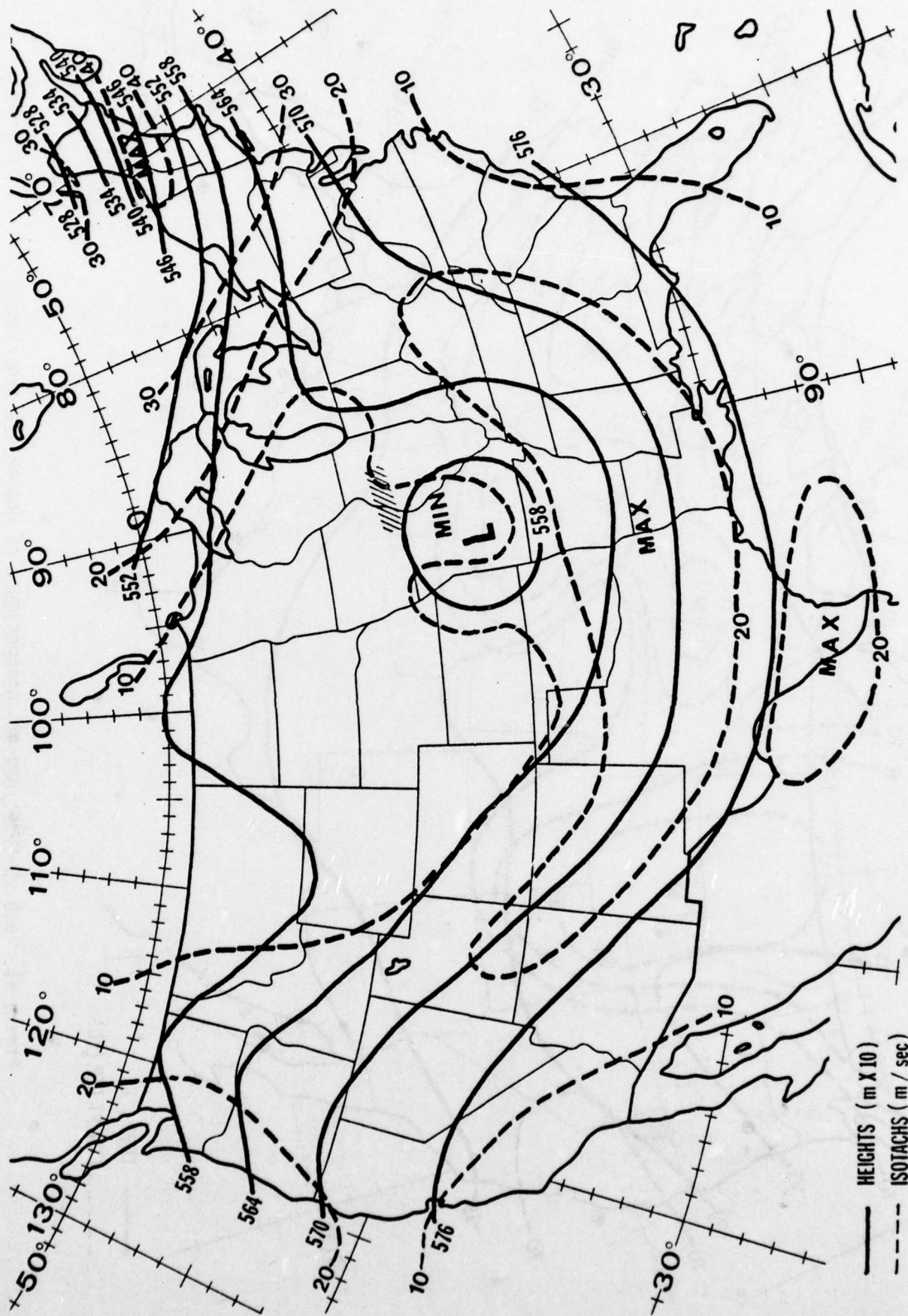


Figure 52. 500 mb HEIGHTS/ISOTACHS - 25 MAR 78 00Z ANALYSIS

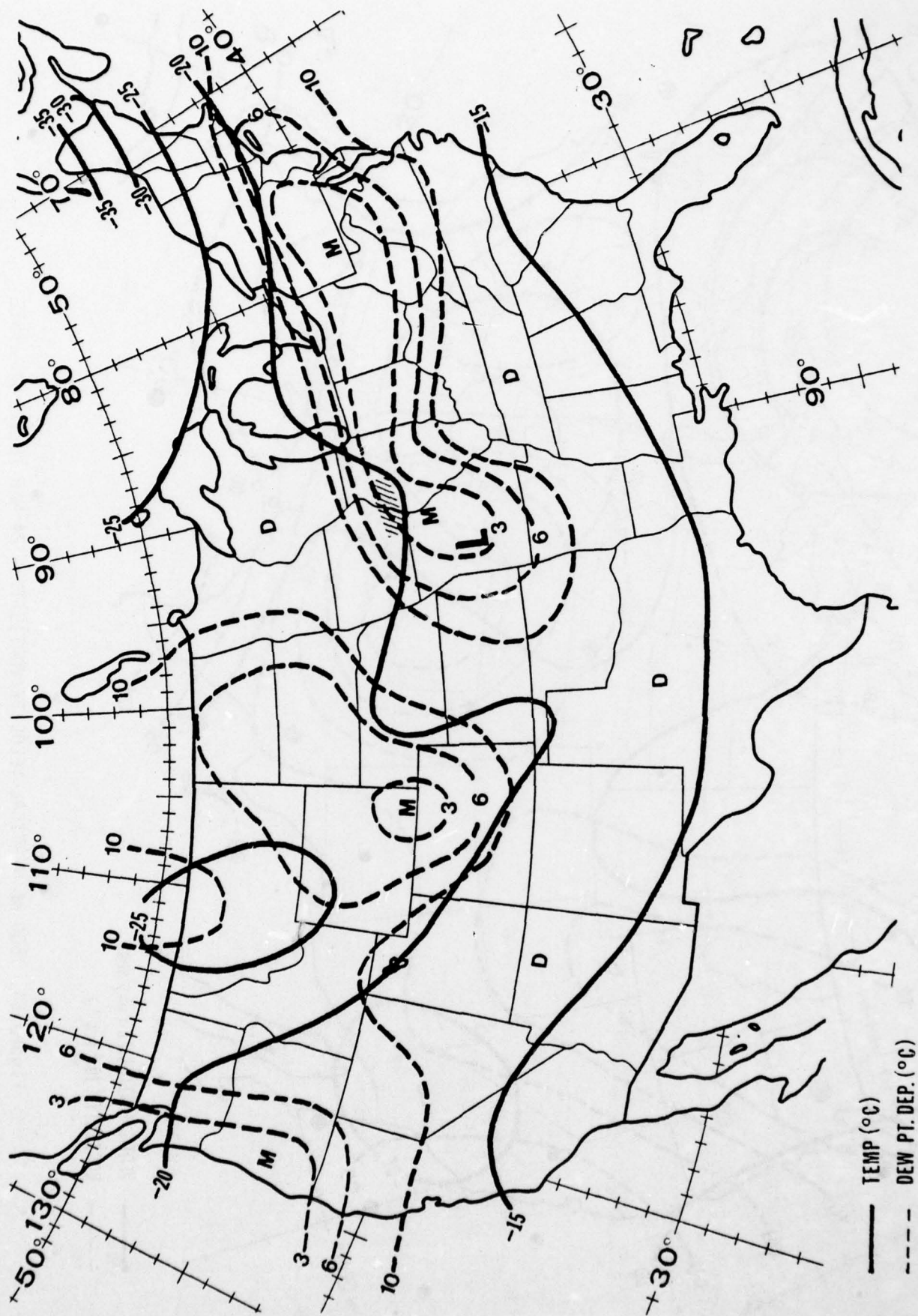


Figure 53. 500 mb TEMP./DEW PT. DEPRESSION - 25 MAR 78 00Z ANALYSIS

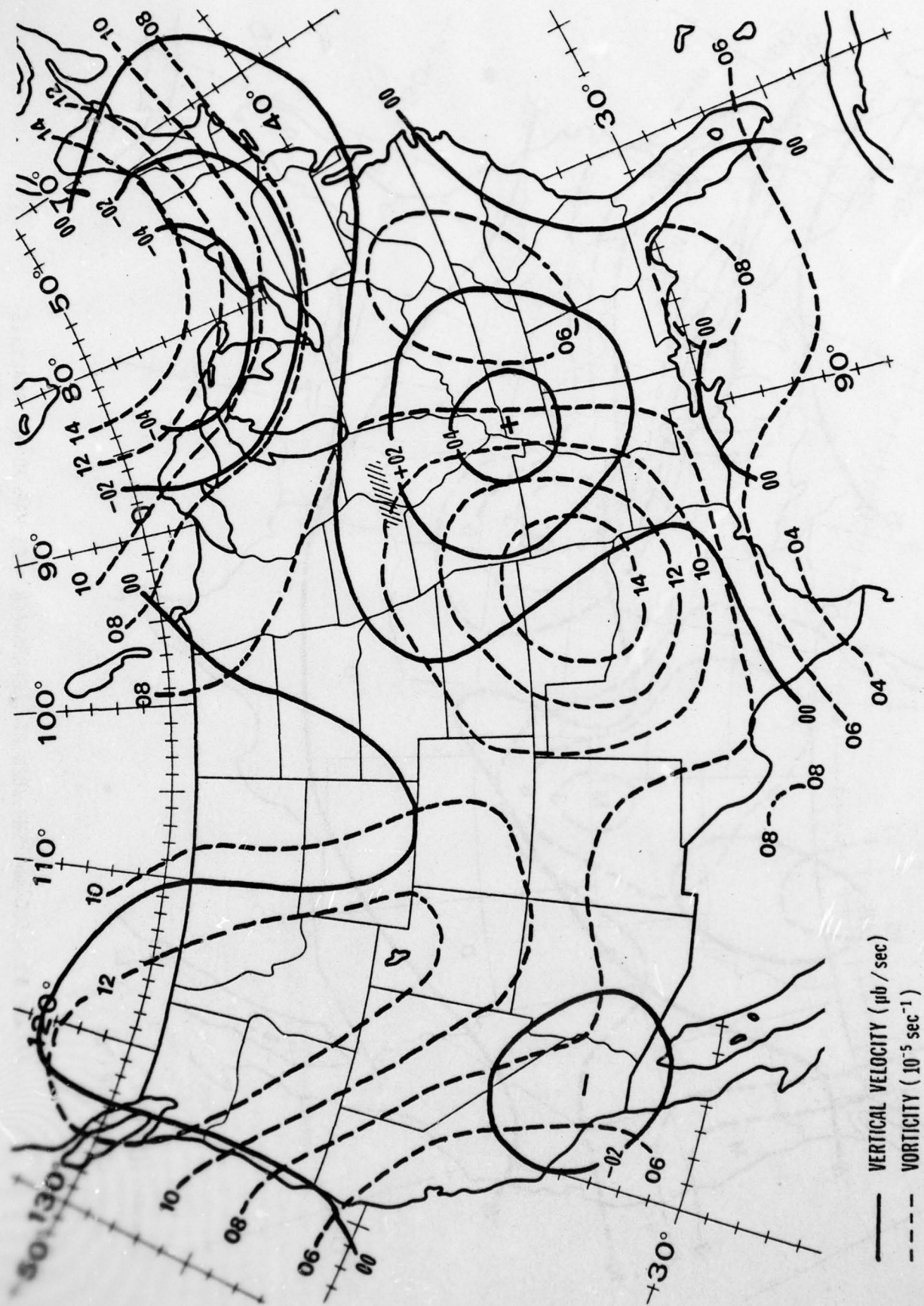


Figure 54. 500 mb VERTICAL VELOCITY/VORTICITY - 24 MAR 78 12Z ANALYSIS

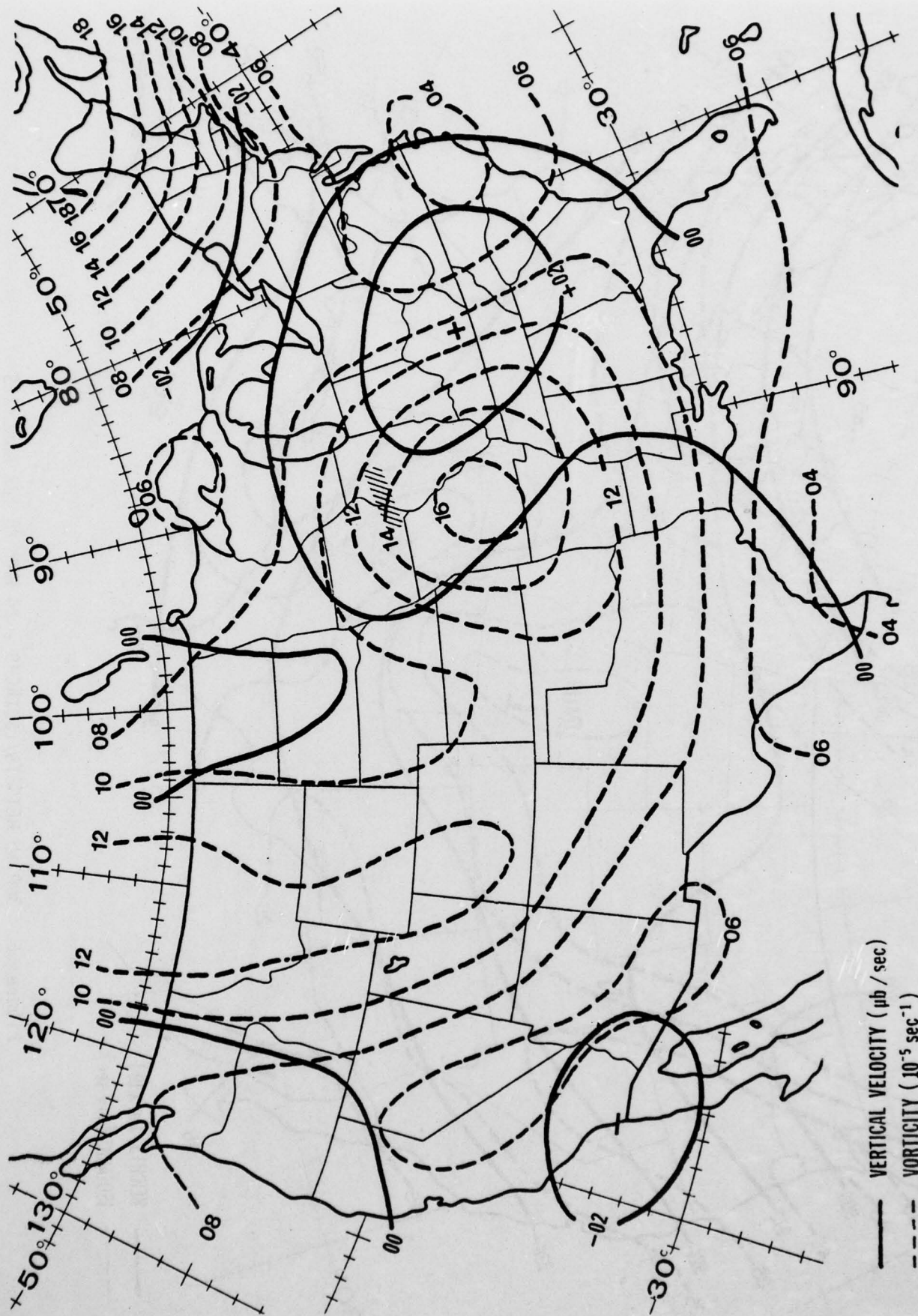


Figure 55. 500 mb VERTICAL VELOCITY/VORTICITY - 25 MAR 78 00Z ANALYSIS

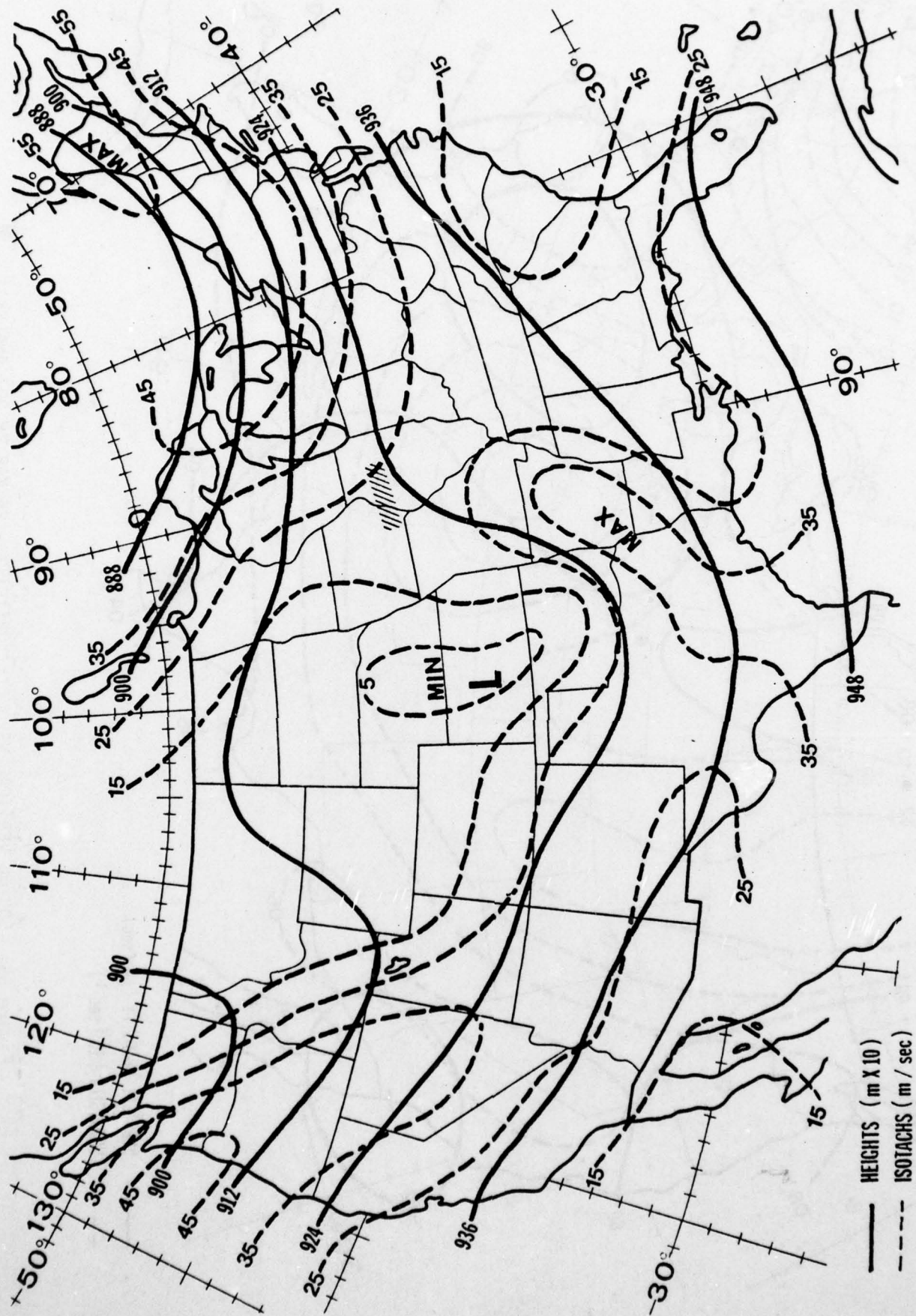


Figure 56. 300 mb HEIGHTS/ISOTACHS - 24 MAR 78 12Z ANALYSIS

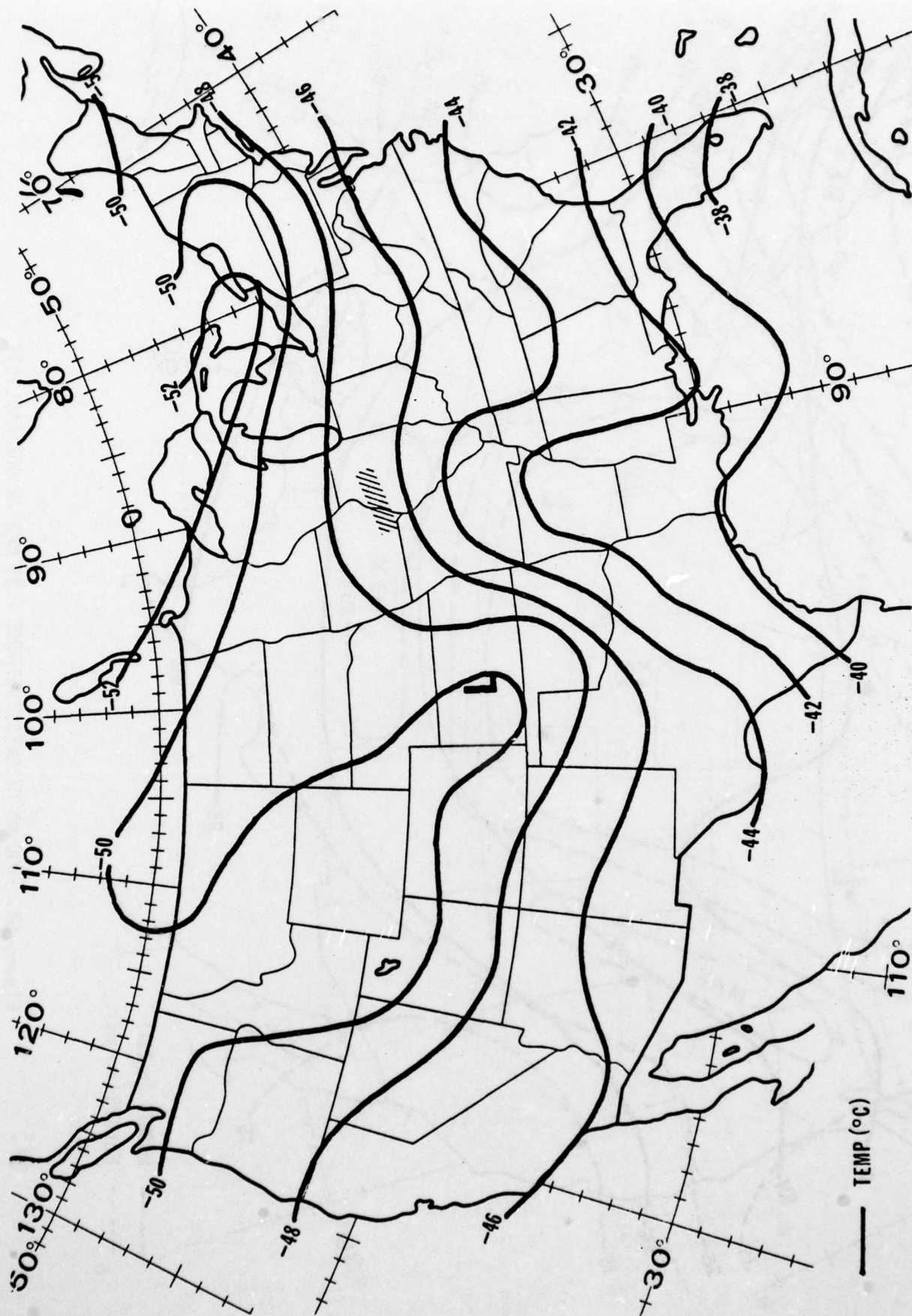


Figure 57. 300 mb TEMPERATURE - 24 MAR 78 12Z ANALYSIS

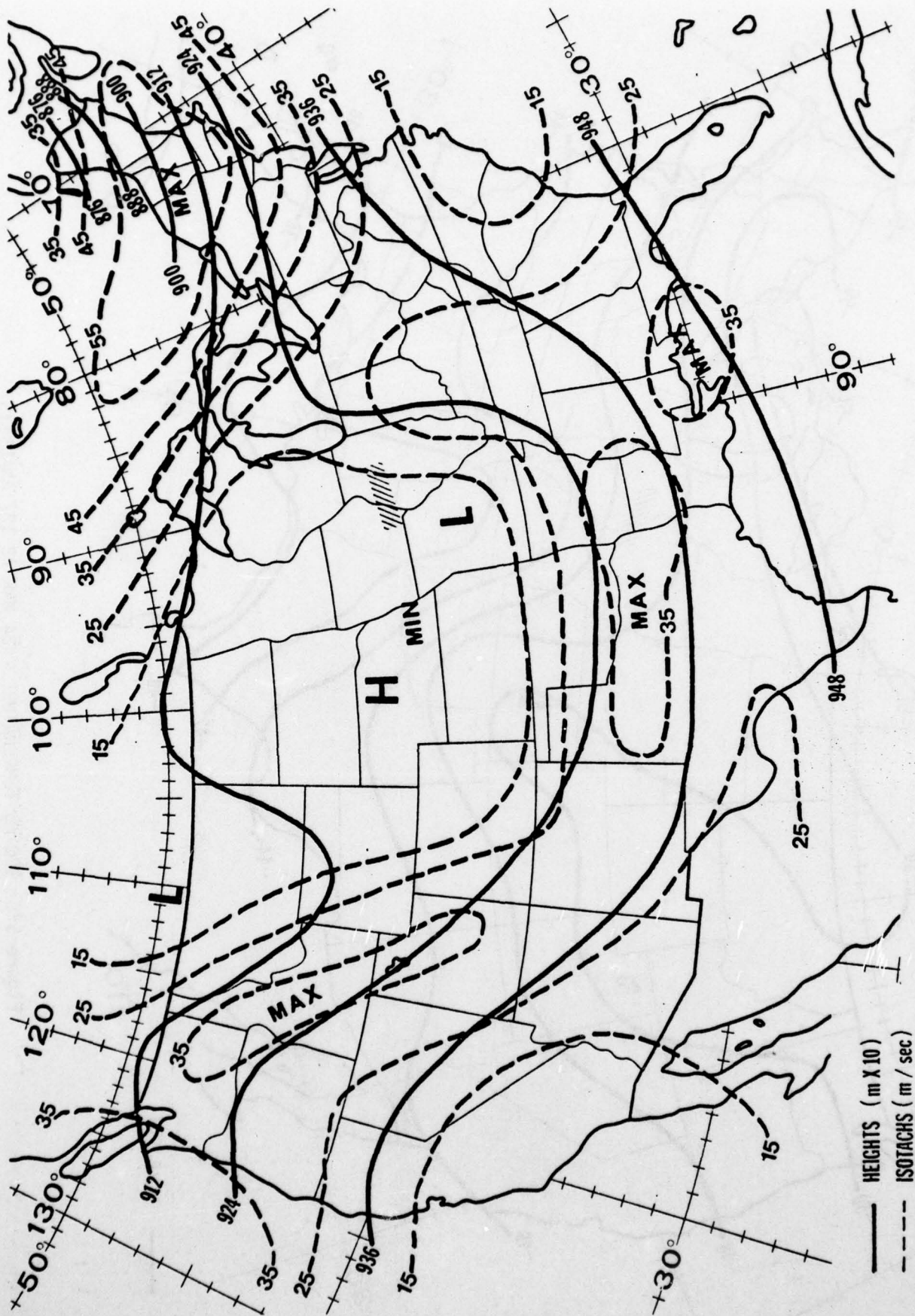


Figure 58. 300 mb HEIGHTS/ISOTACHS - 25 MAR 78 00Z ANALYSIS

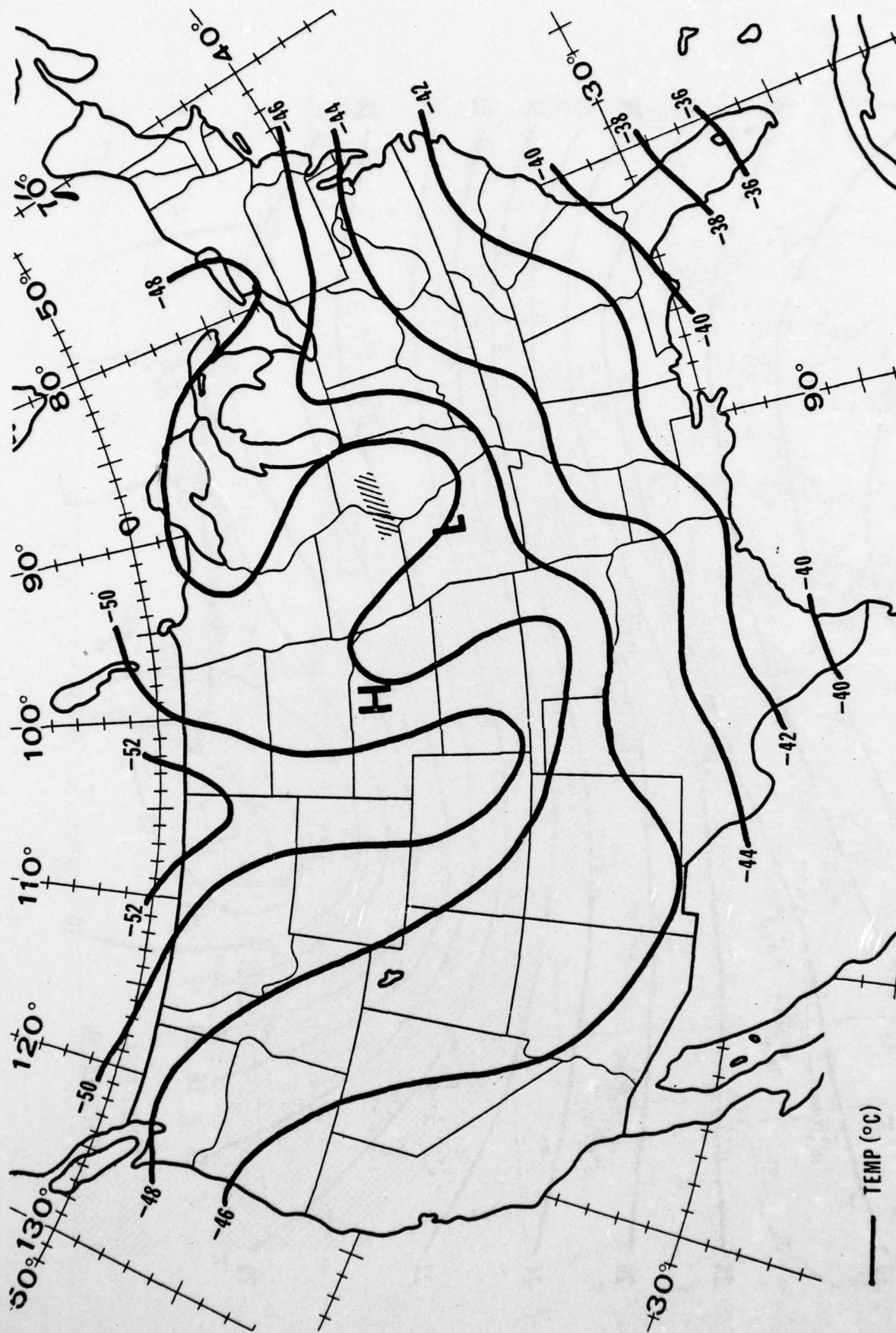


Figure 59. 300 mb TEMPERATURE - 25 MAR 78 00Z ANALYSIS

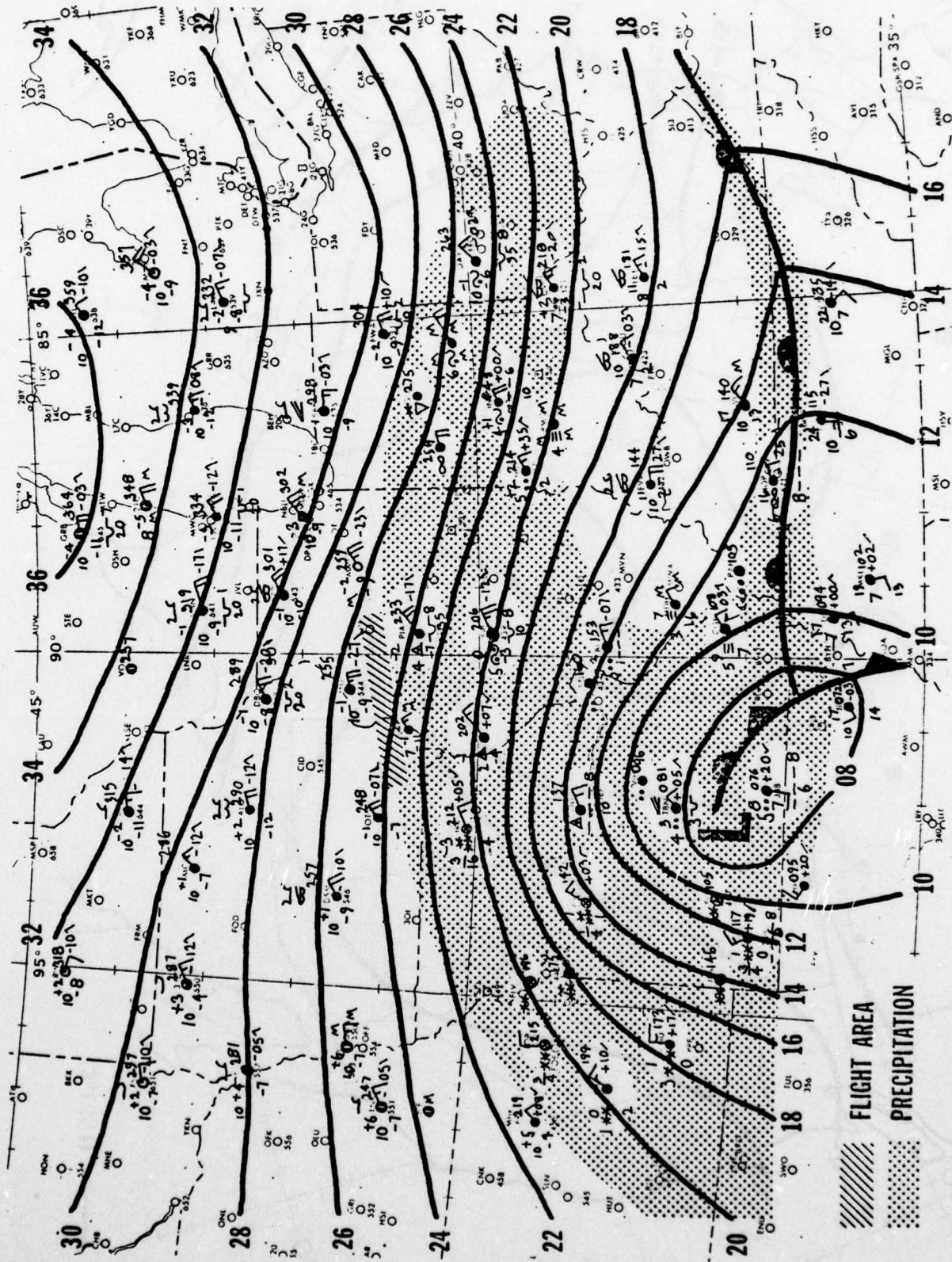


Figure 60. LOCAL SURFACE PRESSURE - 24 MAR 78 18Z ANALYSIS

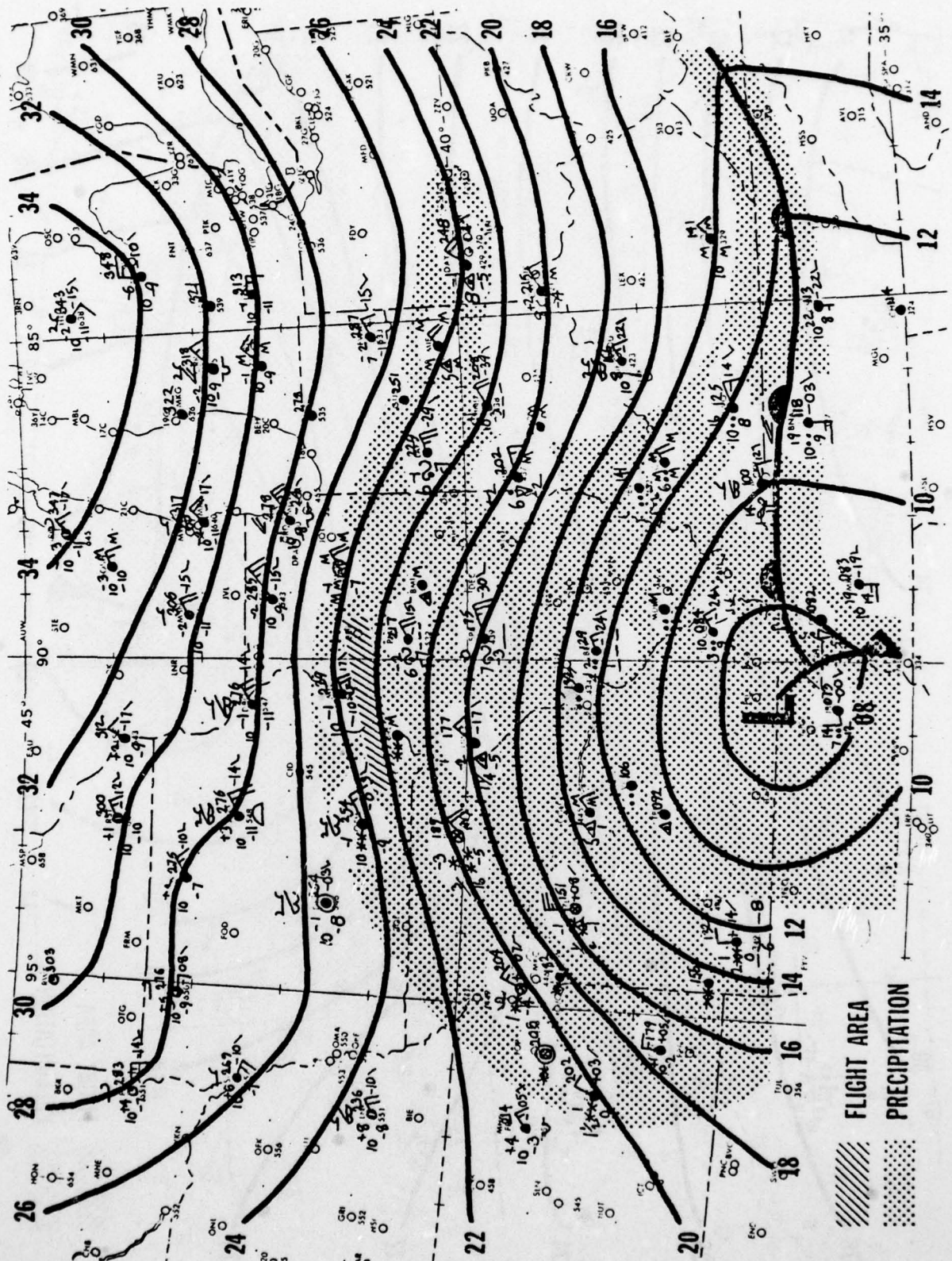


Figure 61. LOCAL SURFACE PRESSURE - 24 MAR 78 21Z ANALYSIS

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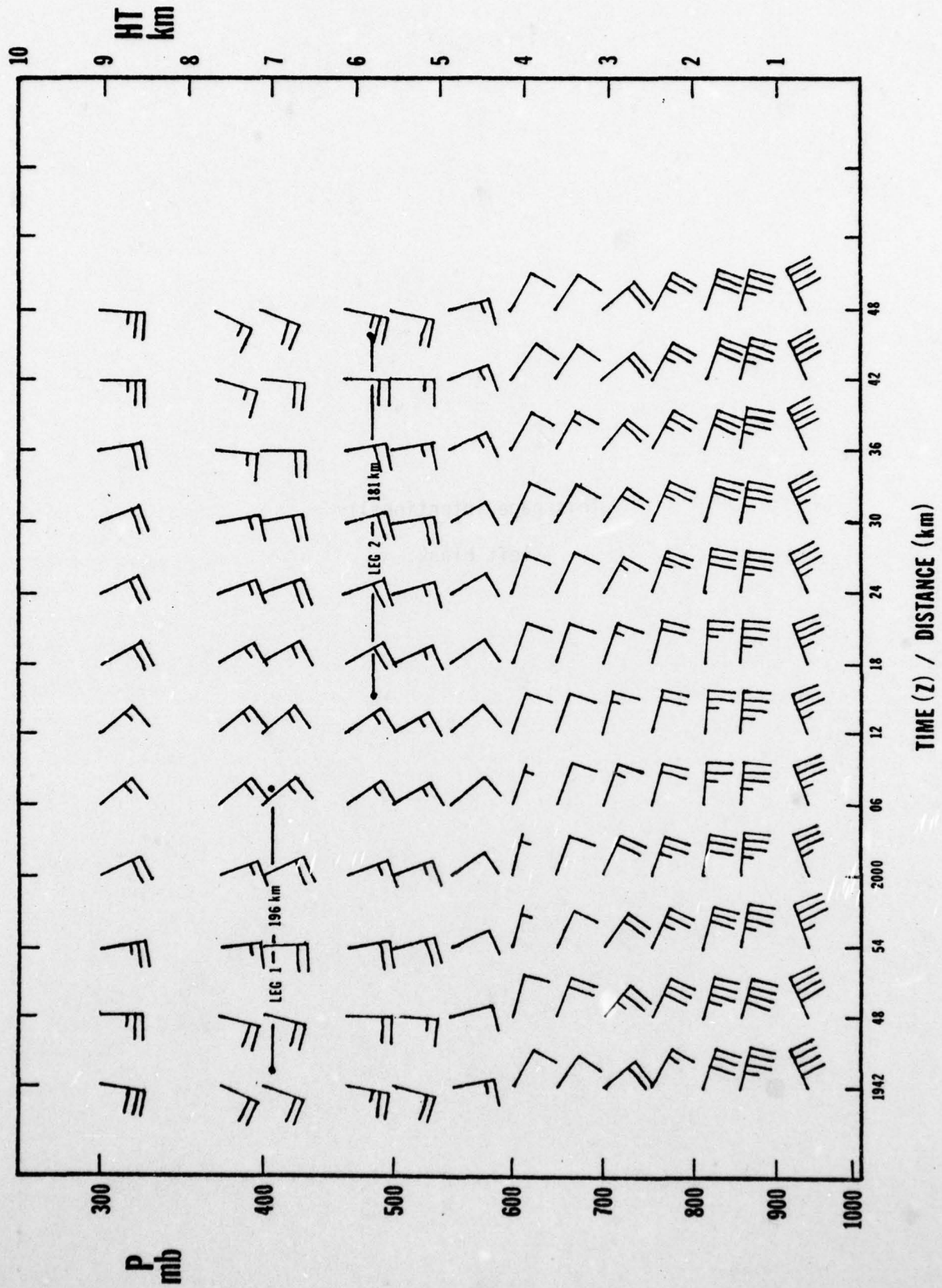


Figure 63. WIND CROSS-SECTION LEGS 1 AND 2 - 24 MAR 78 ANALYSIS

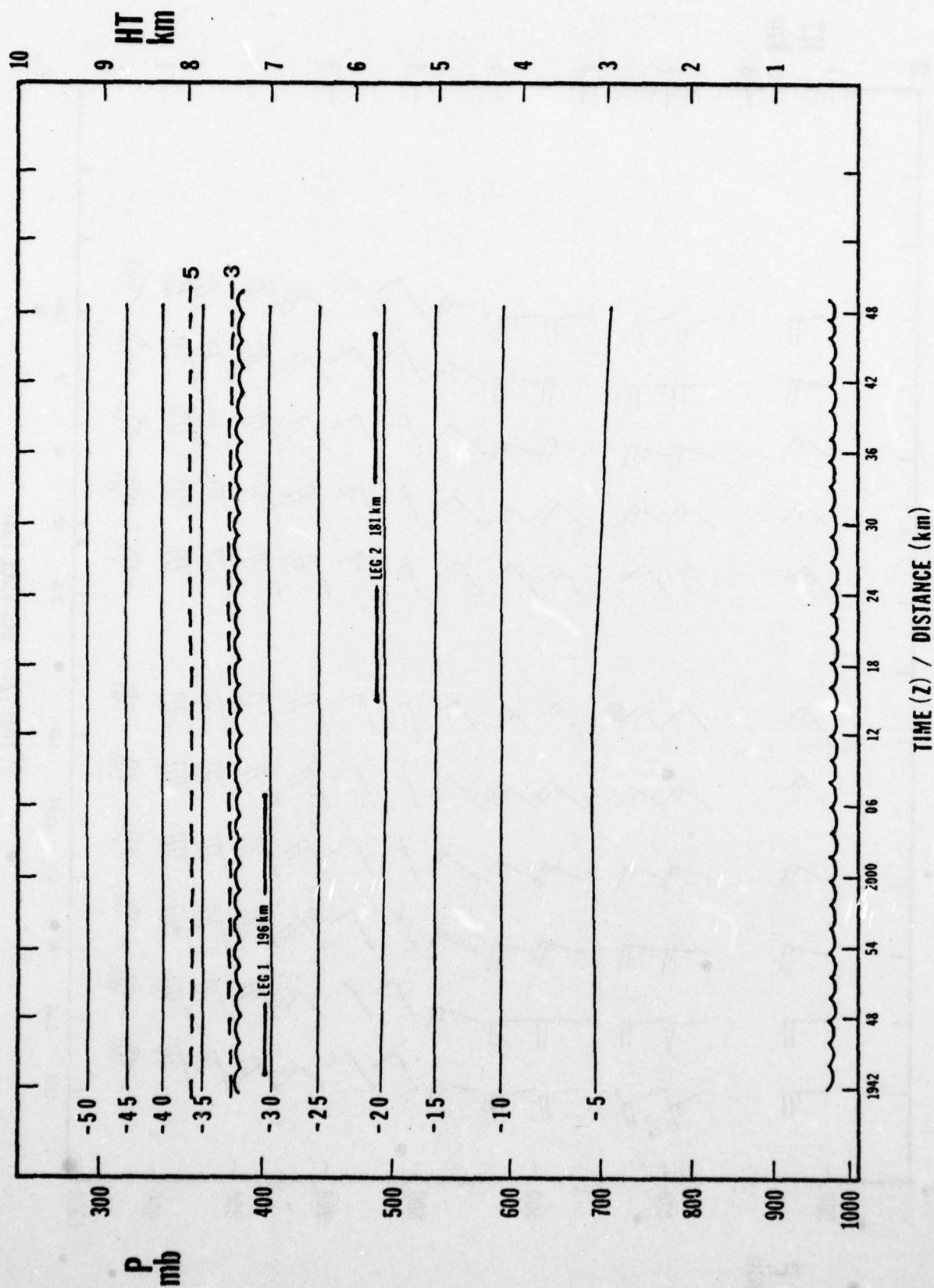


Figure 64. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 1 AND 2 - 24 MAR 78 ANALYSIS

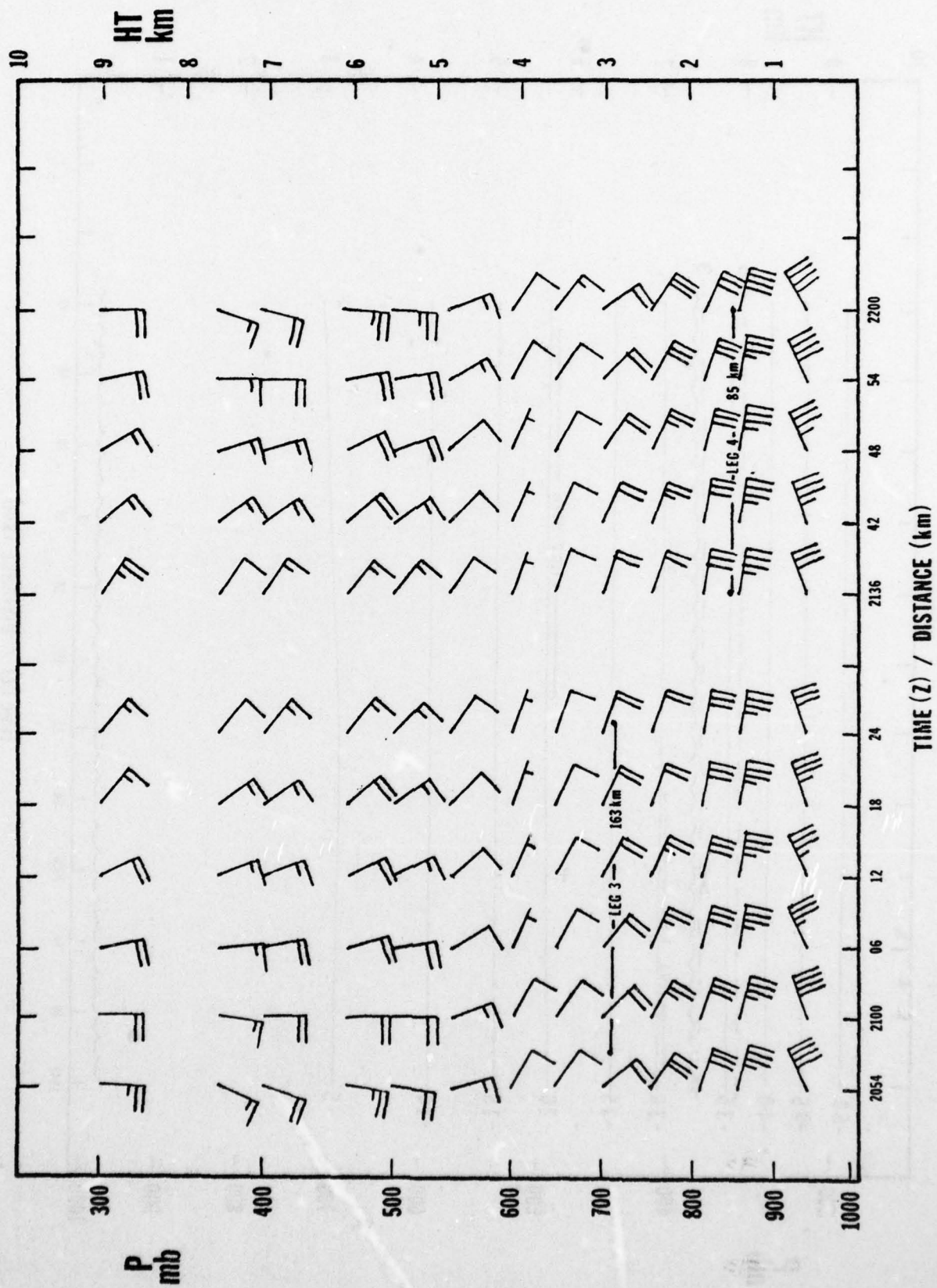
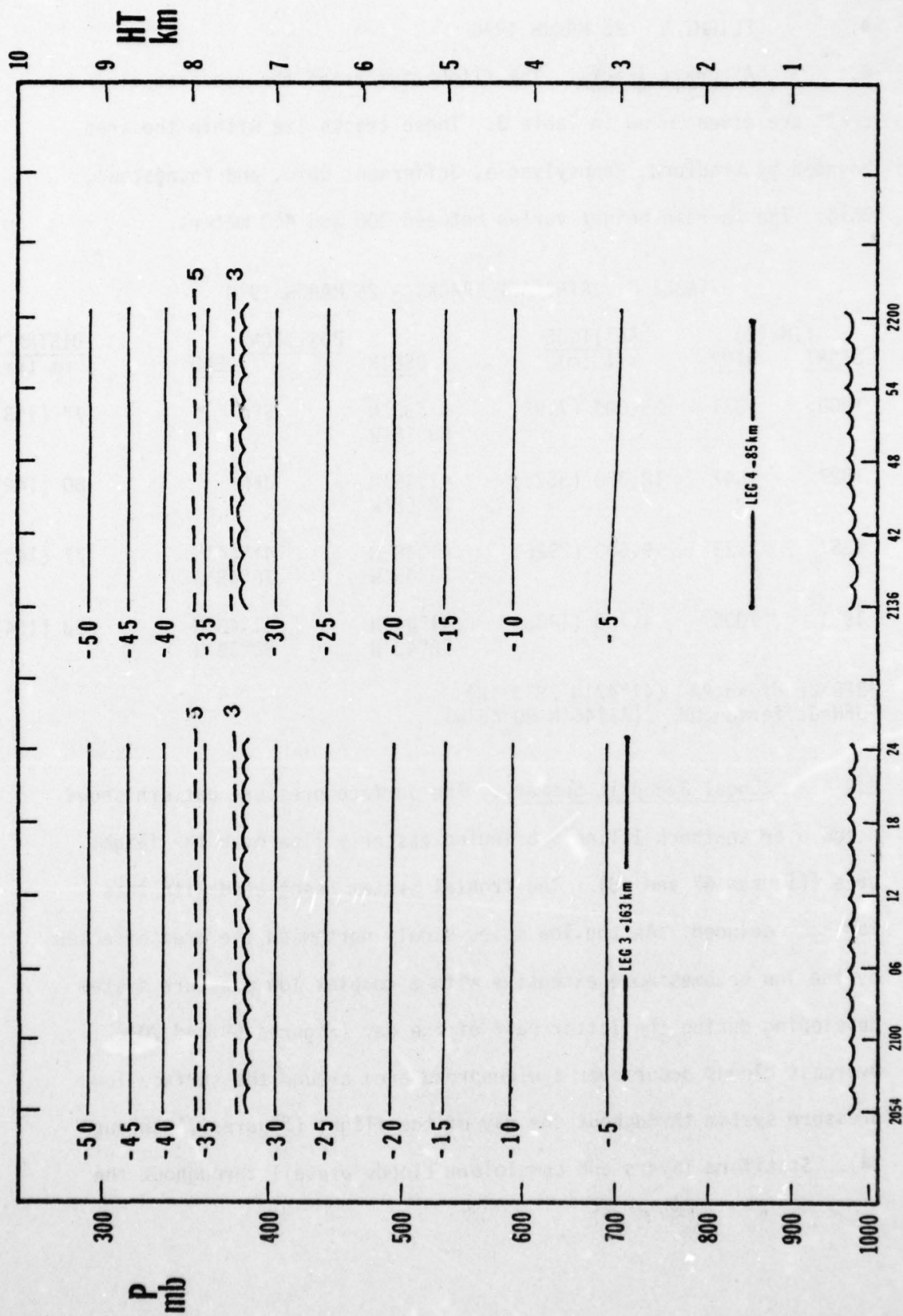


Figure 65. WIND CROSS-SECTION LEGS 3 AND 4 - 24 MAR 78 ANALYSIS



TIME (Z) / DISTANCE (km)

Figure 66. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 3 AND 4 - 24 MAR 78 ANALYSIS

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SYSTEMS AND APPLIED SCIENCES CORP RIVERDALE MD

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SYNOPTIC ANALYSIS CASE 2. 23 MARCH 1978 - 27 MARCH 1978, (U)

JAN 79 D CHIN, H D HAMILTON

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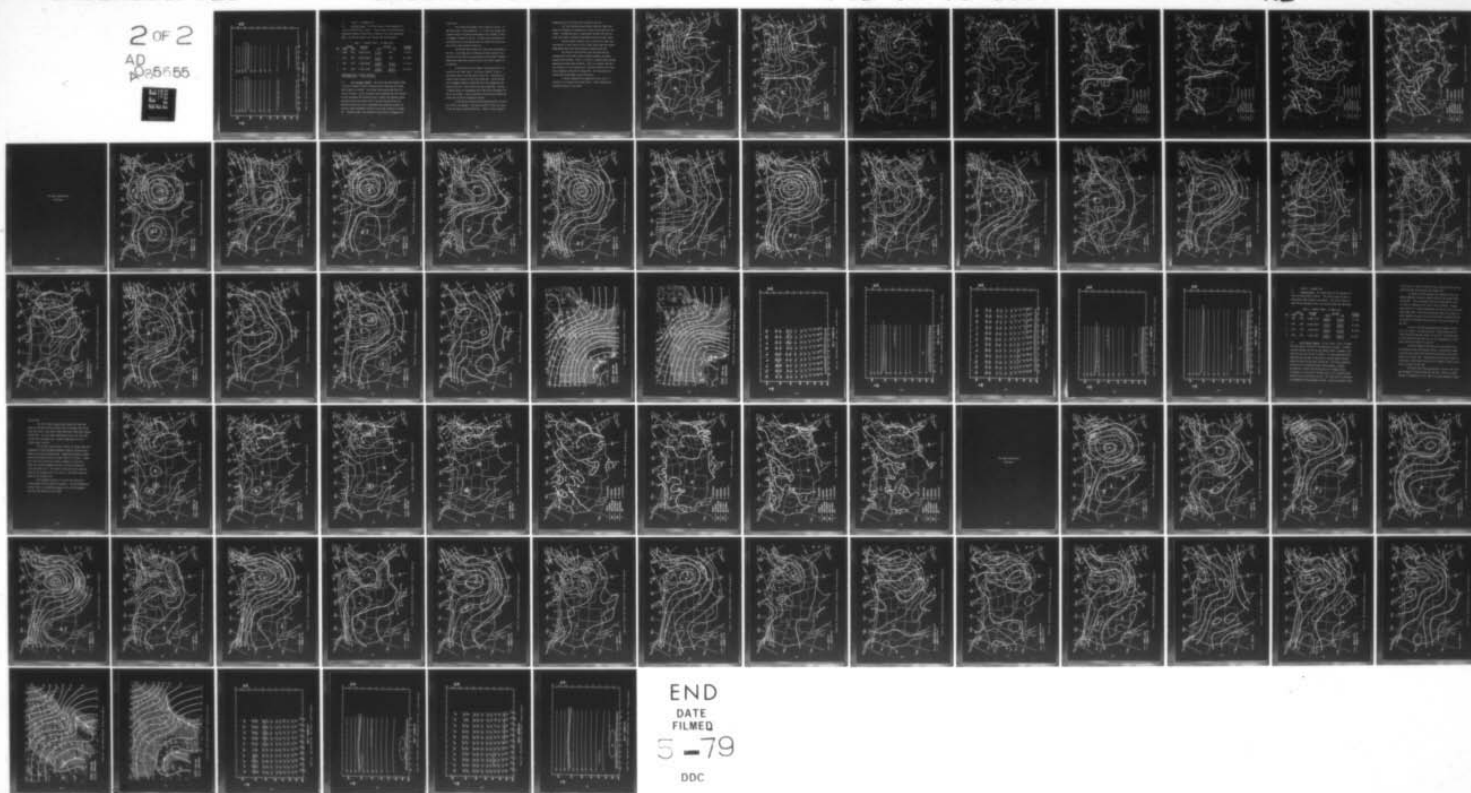
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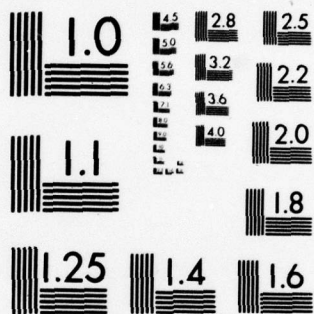
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MICROCOPY RESOLUTION TEST CHART
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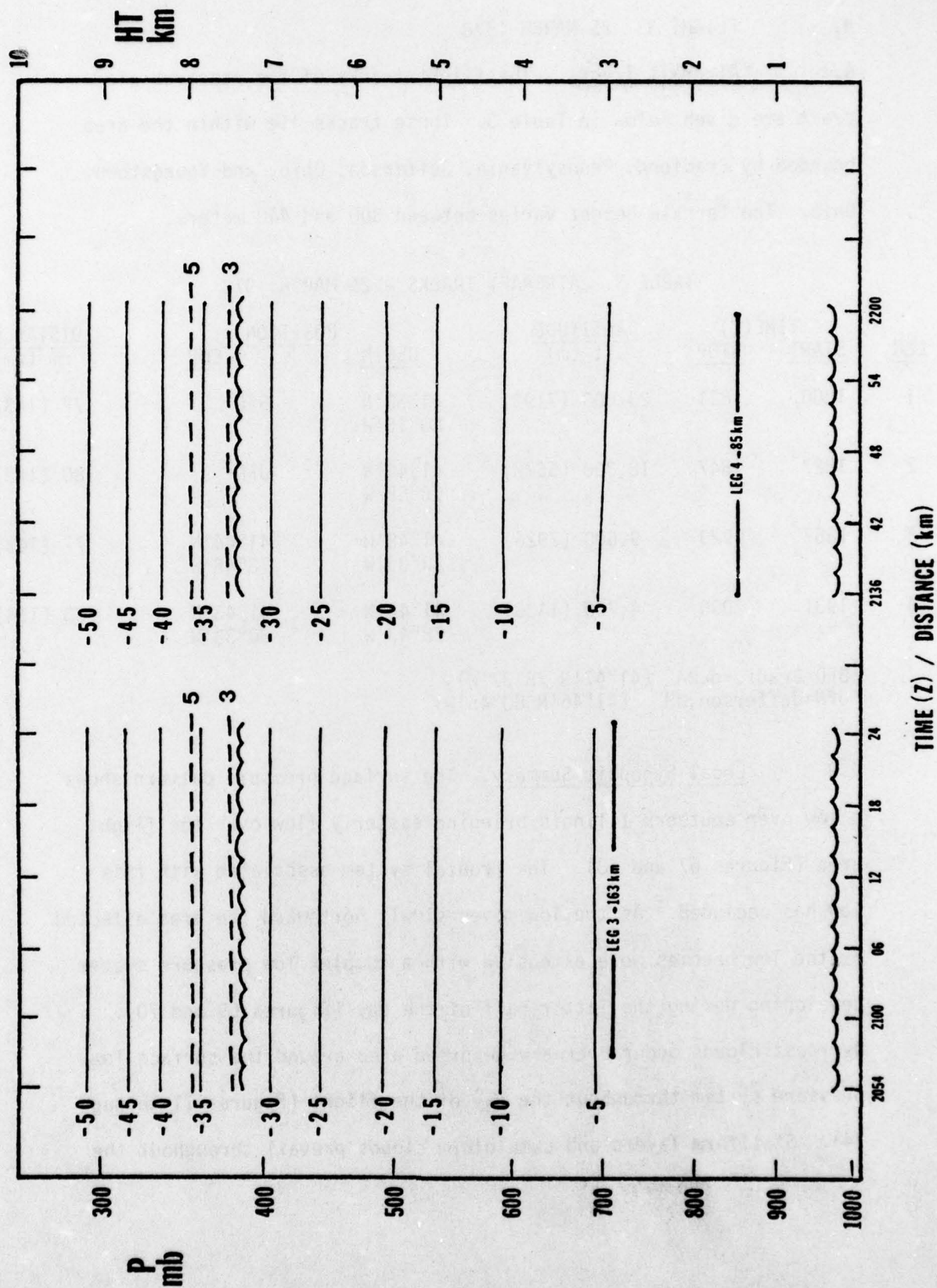


Figure 66. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 3 AND 4 - 24 MAR 78 ANALYSIS

4. FLIGHT 3 25 MARCH 1978

4.1 Aircraft Tracks. The flight tracks of the research aircraft are given below in Table 3. These tracks lie within the area bounded by Bradford, Pennsylvania, Jefferson, Ohio, and Youngstown, Ohio. The terrain height varies between 300 and 440 meters.

TABLE 3. AIRCRAFT TRACKS - 25 MARCH 1978

LEG	TIME(Z)		ALTITUDE ft (m)	POSITION		DISTANCE nm (km)
	START	STOP		BEGIN	END	
1	1800	1821	23,600 (7193)	41°30'N 80°15'W	BFD ¹	77 (143)
2	1827	1847	18,300 (5578)	41°46'N 78°58'W	JFN ²	80 (148)
3	1857	1923	9,600 (2926)	41°48'N 80°35'W	41°44'N 78°48'W	77 (143)
4	1931	2000	4,700 (1433)	41°44'N 78°43'W	41°43'N 80°33'W	83 (154)

¹BFD=Bradford,PA (41°47'N 78°37'W)

²JFN=Jefferson,OH (41°46'N 80°45'W)

4.2 Local Synoptic Summary. The surface pressure pattern shows a low over southern Illinois bringing easterly flow over the flight area (Figures 67 and 68). The frontal system associated with this low has occluded. As the low moves slowly northward the area affected by the low becomes more extensive with a complex low pressure system developing during the latter half of the day (Figures 69 and 70). Overcast clouds occur over a widespread area around the surface low pressure system throughout the day of the flight (Figures 71 through 74). Statiform layers and cumuloform clouds prevail throughout the

flight area.

The surface low extends aloft through all levels. At 850 mb the low is quite extensive. It is initially located over southern Missouri and moves northeastward into southern Illinois and deepens (Figures 75 and 77). A broad area of warm moist air associated with the low extends over the flight area during the day of the flight (Figures 76 and 78).

The 700 mb level reflects the large area influenced by this low. The flight area is affected by moist southerly flow ahead of the low with an isotach maximum of $20\text{--}25 \text{ msec}^{-1}$ heading toward the flight area during the day of the flight (Figures 79 through 82).

At 500 mb the low lies about 2° longitude west of its location at the lower levels. An area of 30 msec^{-1} winds is positioned south of the low center (Figure 83). Warm moist air extends north and east of this low (Figure 84). During the day the low deepens slightly (Figure 85) while the temperature and moisture diminish by the end of the day (Figure 86). An area of upward moving air encompasses the flight region throughout the day of the flight. A zone of positive vorticity moves toward the flight area at 500 mb (Figures 87 and 88).

At 300 mb the low moves from southern Missouri to southern Illinois and deepens. An area of 35 msec^{-1} winds lies south of the low center (Figure 89 and 91). There is little change in

temperature over the flight area (Figures 90 and 92).

The local surface pressure charts show the flight area under the influence of southeasterly flow during the period of the flight. A widespread area of precipitation extends from the low center and frontal occlusion northeastward over the flight tracks.

Surface reports indicate rain, freezing rain, snow, and snow pellets in the vicinity of the flight tracks where the surface temperatures hover just below freezing (Figures 93 and 94).

The vertical cross-sections show the winds from the southeast near the surface veering through southerly and southwesterly with altitude. There is a layer of slightly above freezing temperatures between 800 and 900 mb. Moist air extends from near the surface to 7.6 km, diminishing in vertical extent as the flight period progresses (Figures 95 through 98). The cloud bases are between 200 and 300 meters above the terrain.

A simple tropopause with temperatures near -63°C is located at 11.0 km over the flight tracks. Little change occurs during the period of the flight.

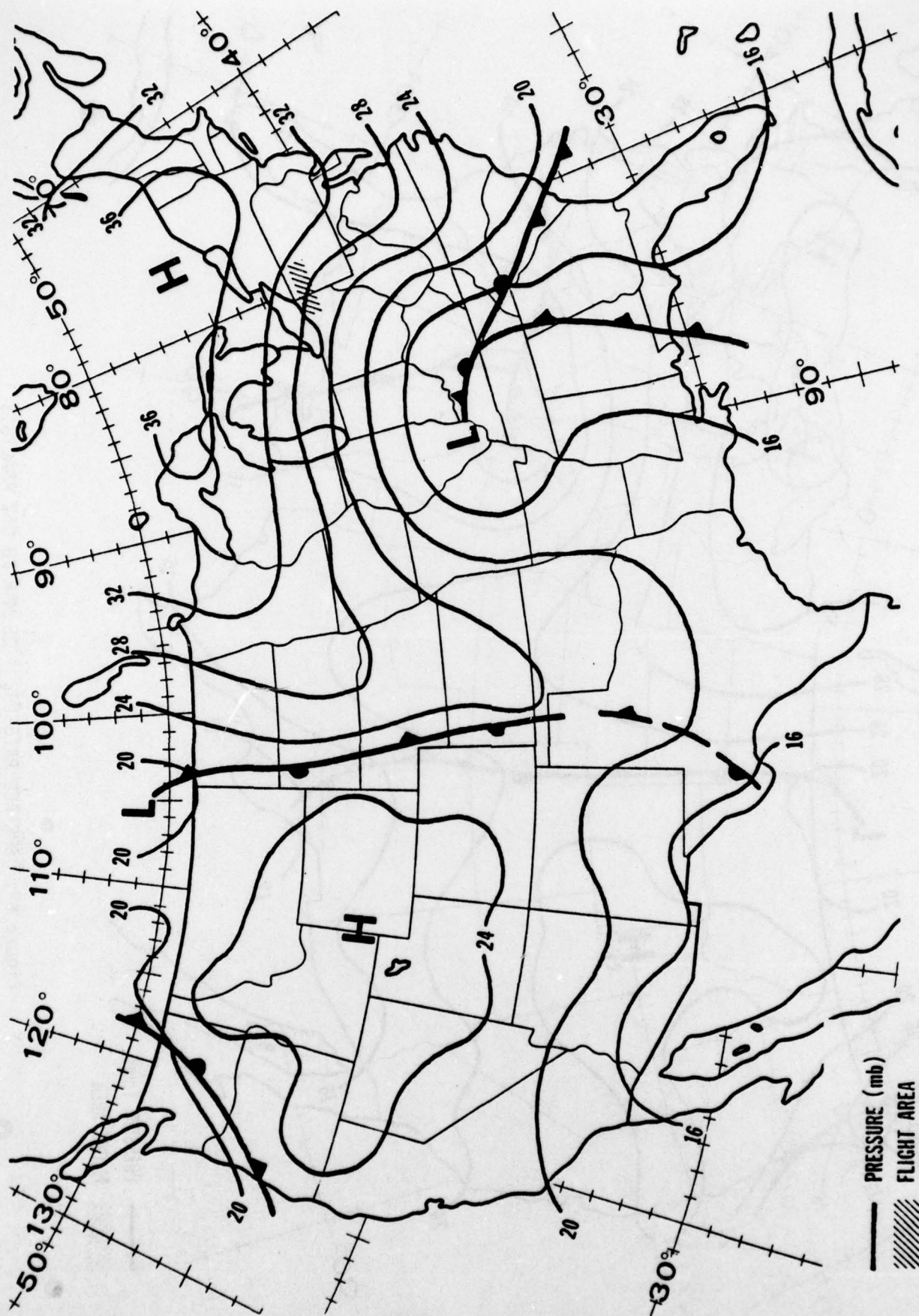


Figure 68. SURFACE PRESSURE - 25 MAR 78 12Z ANALYSIS

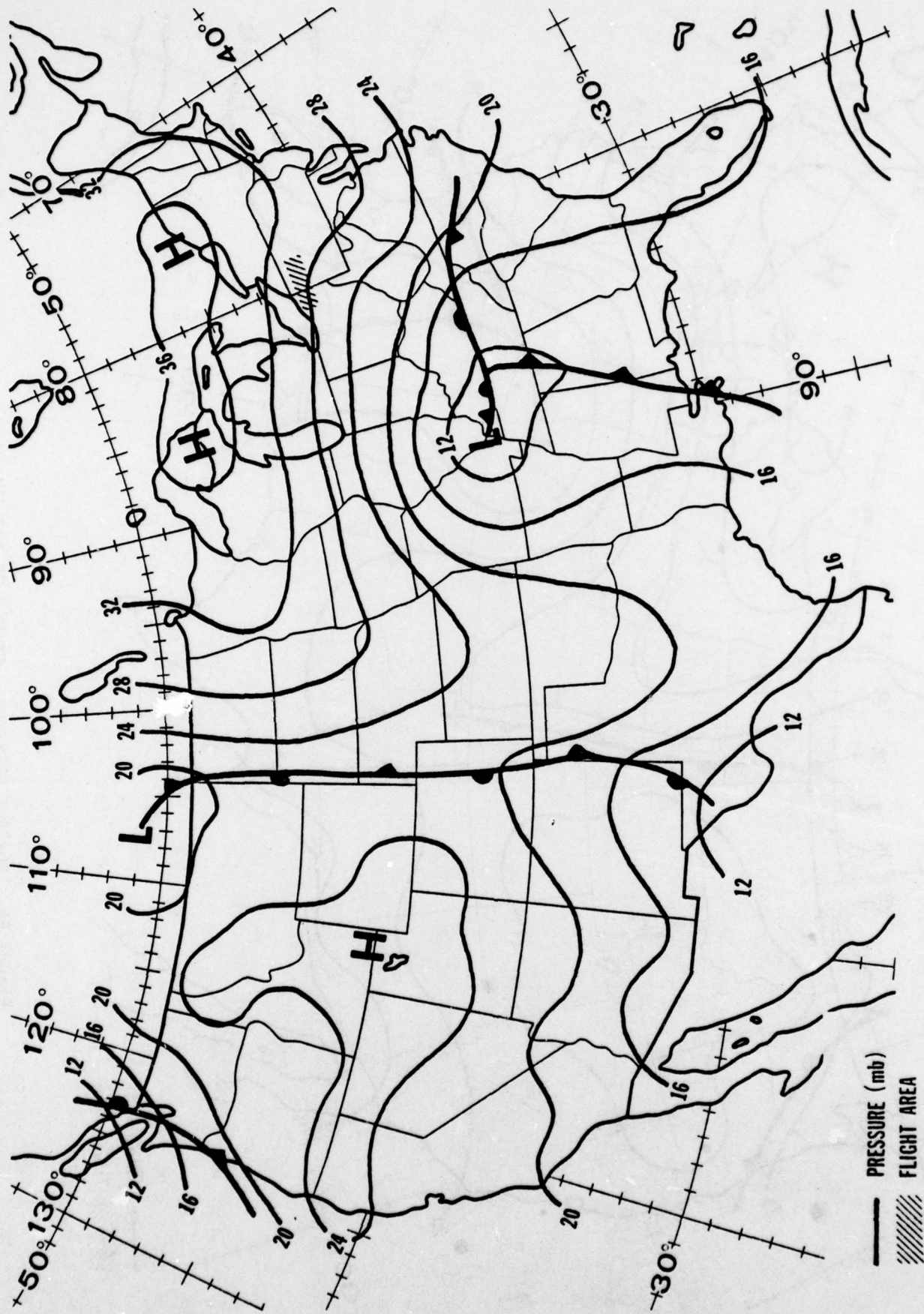


Figure 67. SURFACE PRESSURE - 25 MAR 78 06Z ANALYSIS

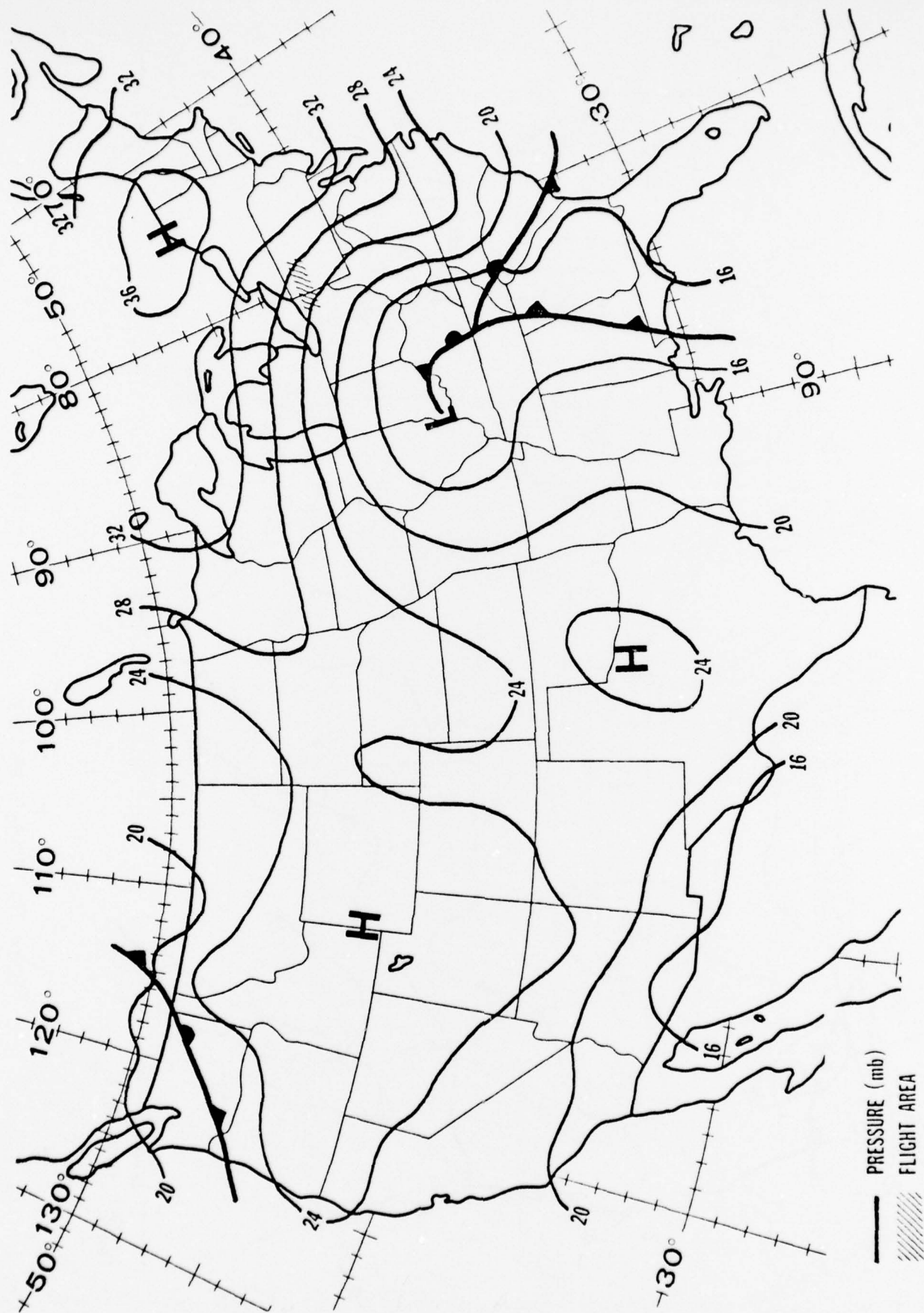


Figure 69. SURFACE PRESSURE - 25 MAR 78 18Z ANALYSIS

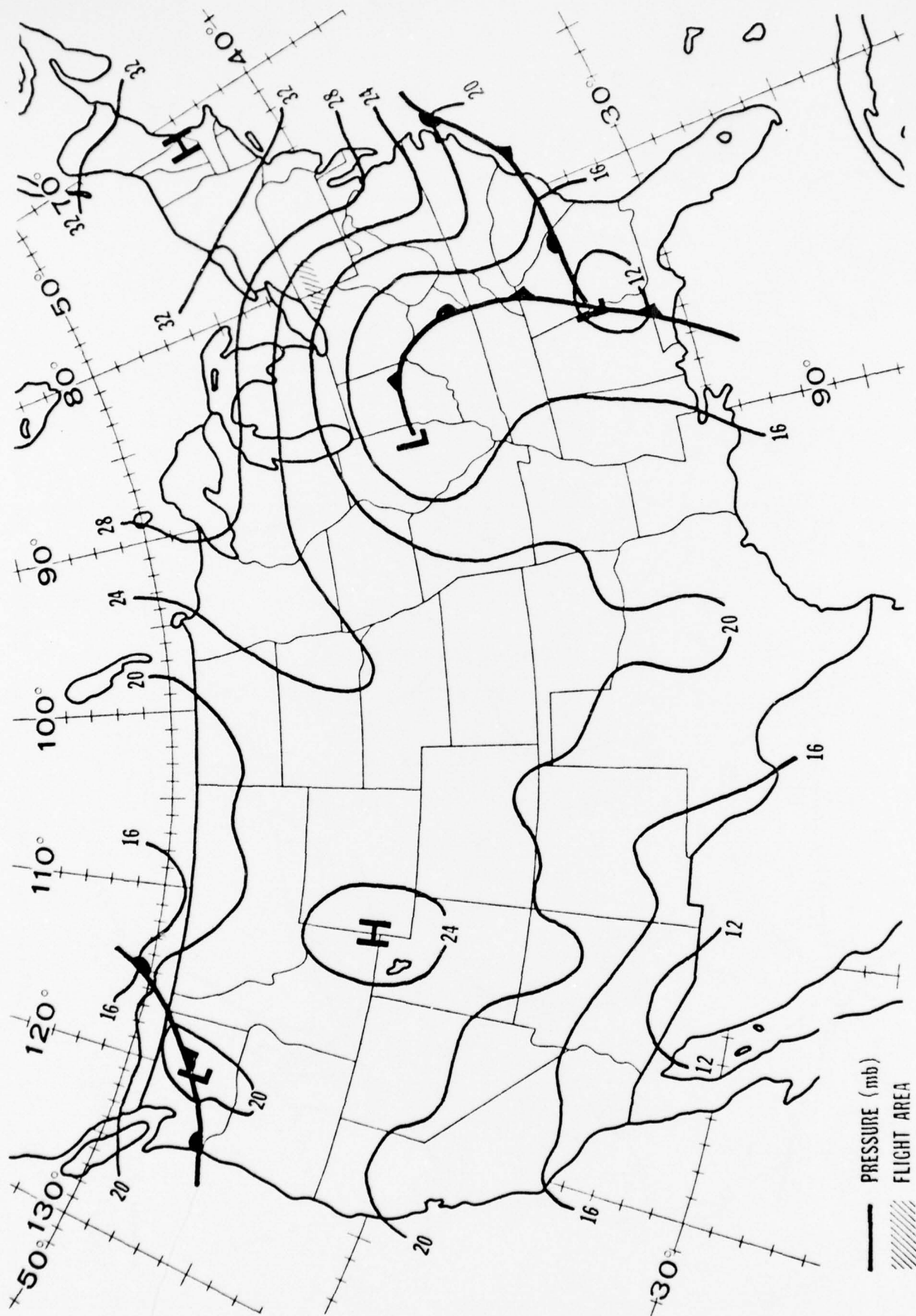


Figure 70. SURFACE PRESSURE - 26 MAR 78 00Z ANALYSIS

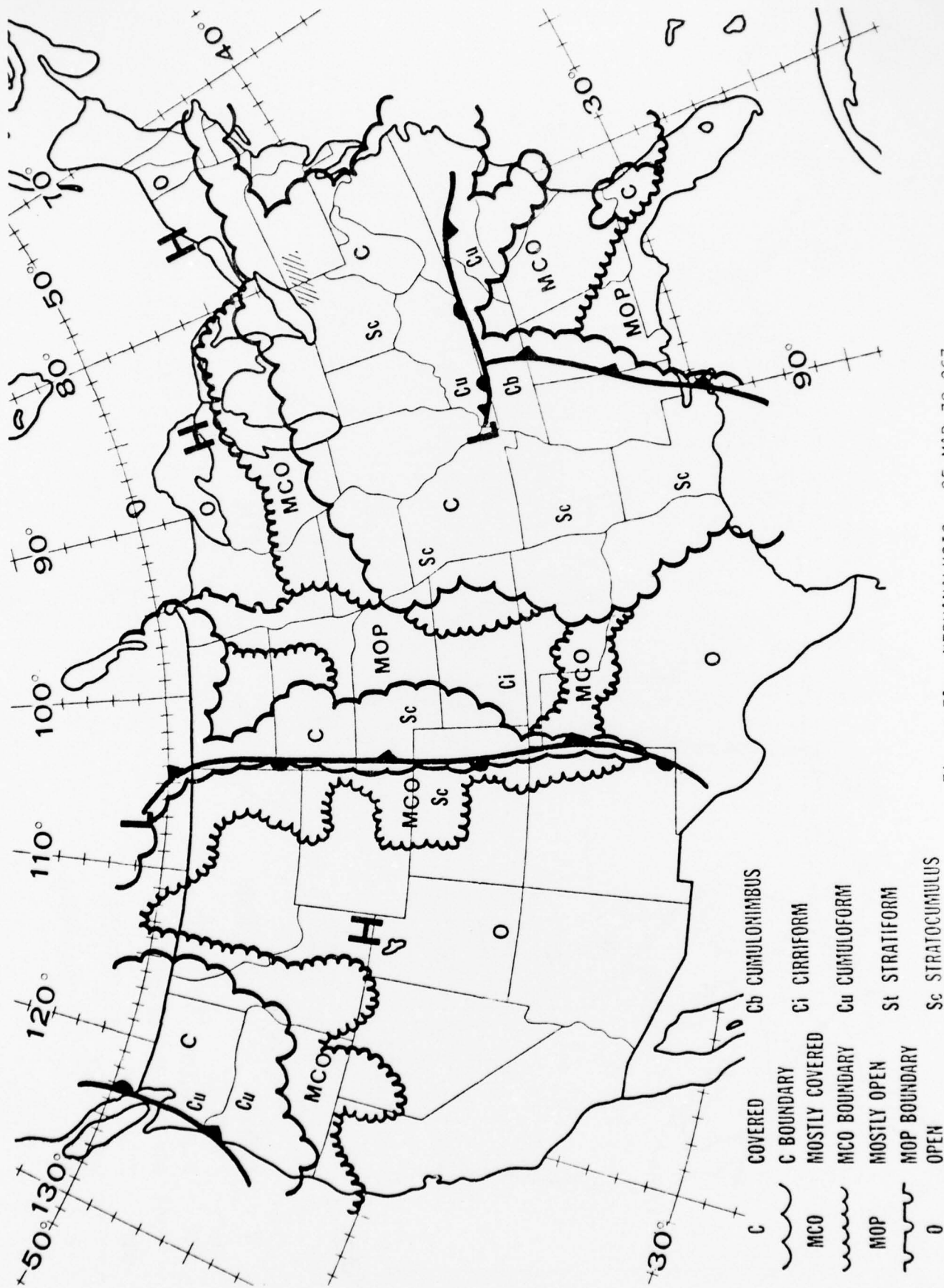


Figure 71. NEPHANALYSIS - 25 MAR 78 06Z

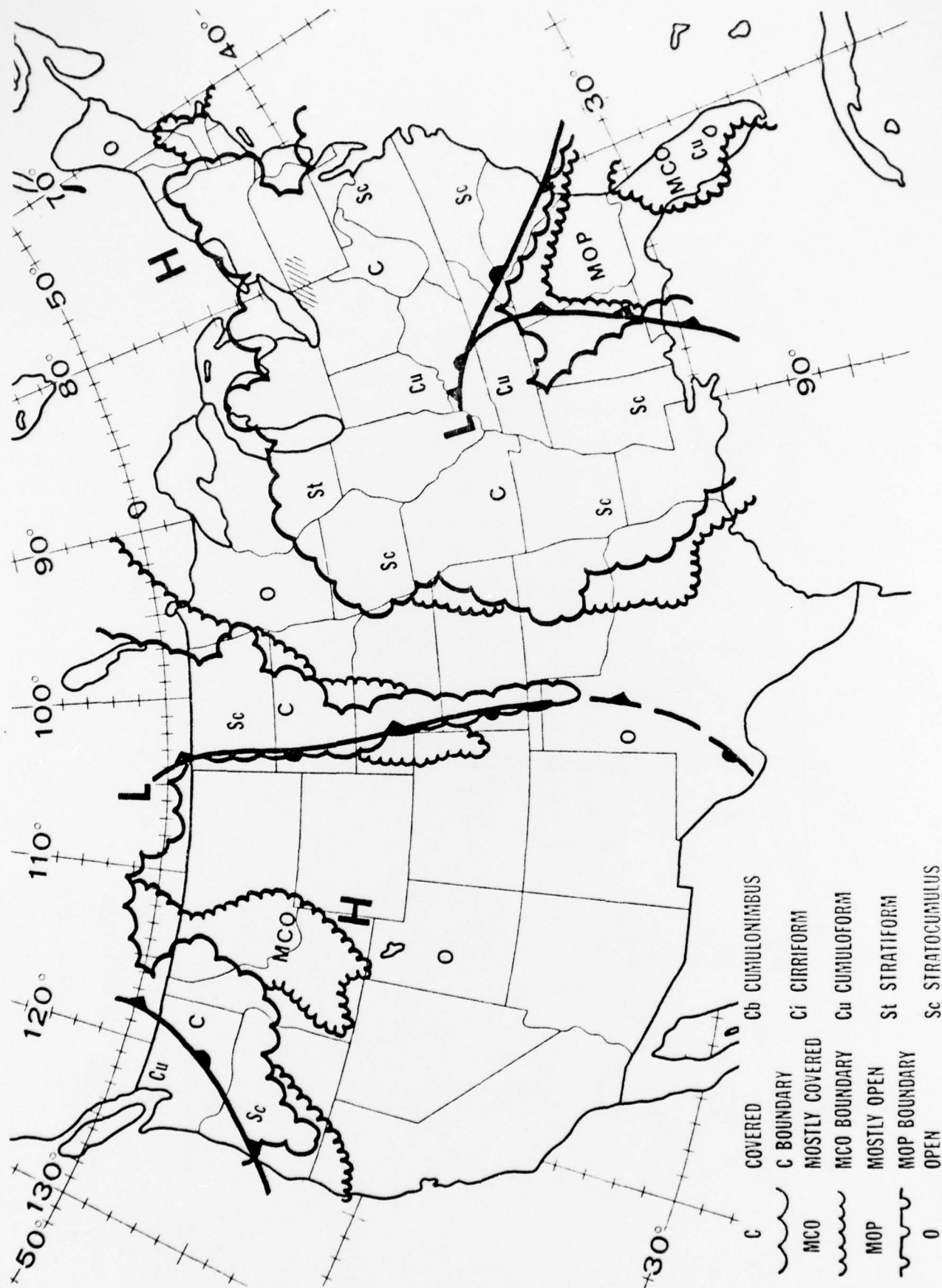


Figure 72. NEPHANALYSIS - 25 MAR 78 12Z

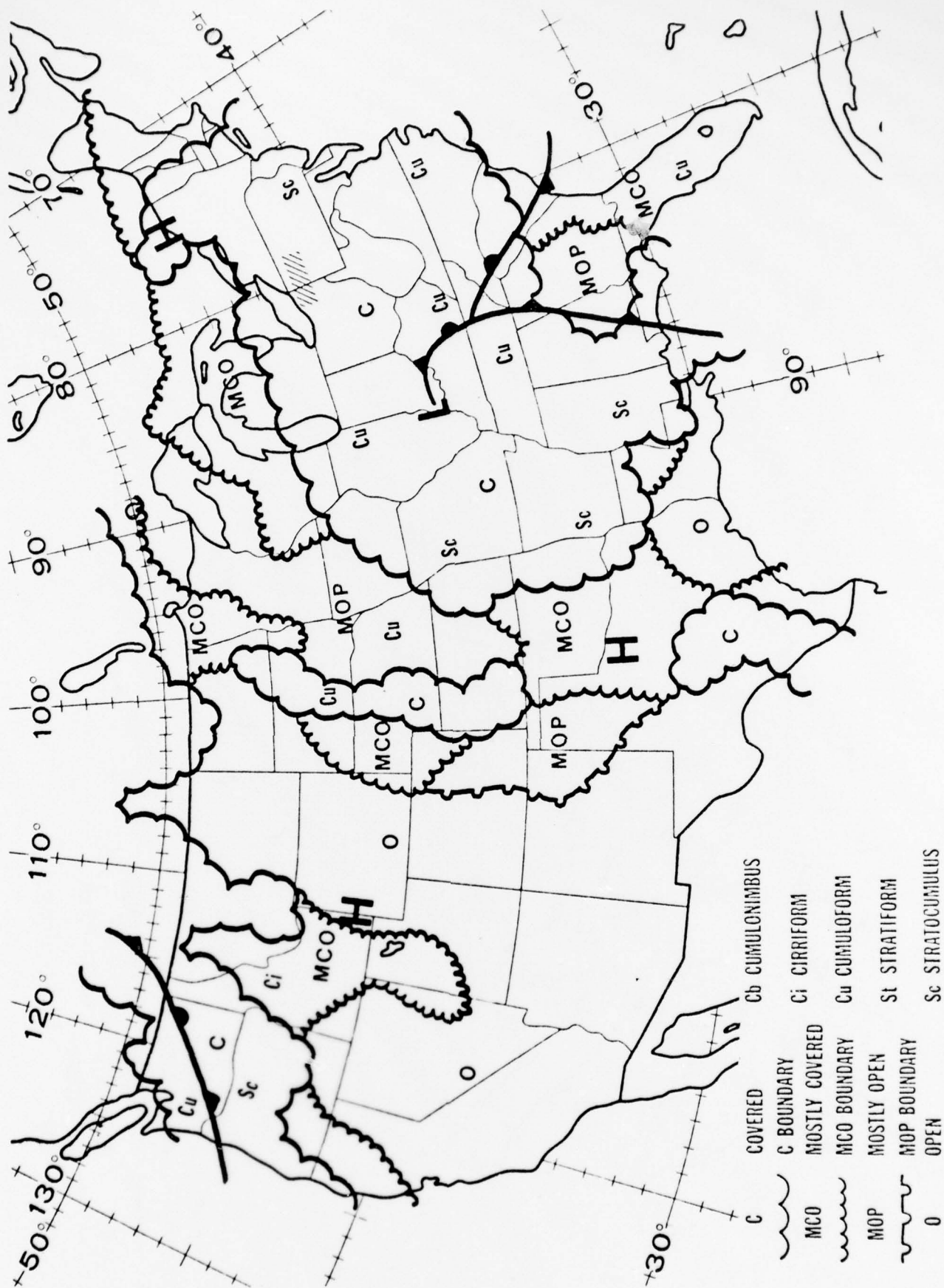


Figure 73. NEPHANALYSIS - 25 MAR 78 18Z

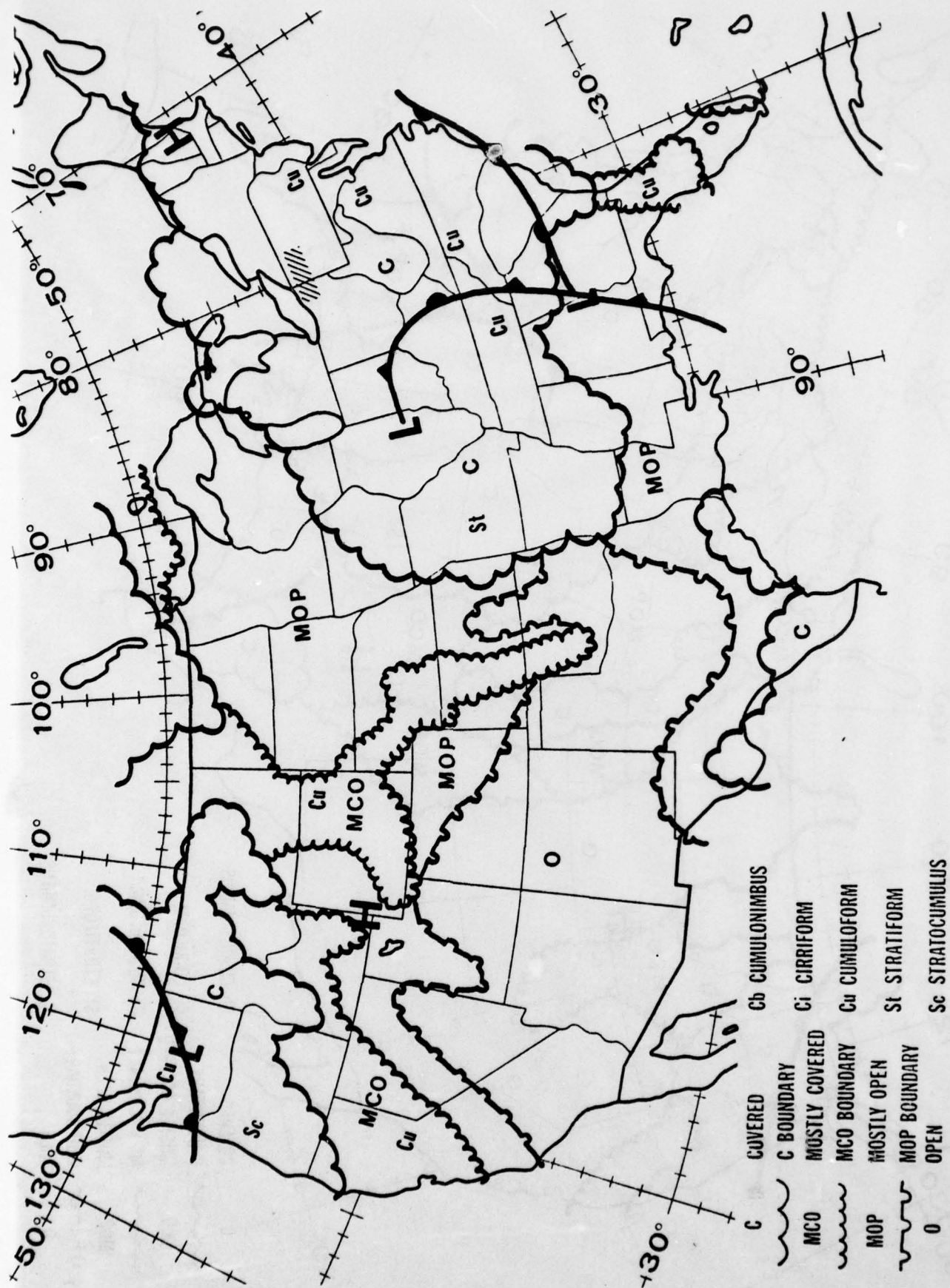


Figure 74. NEPHANALYSIS - 26 MAR 78 00Z

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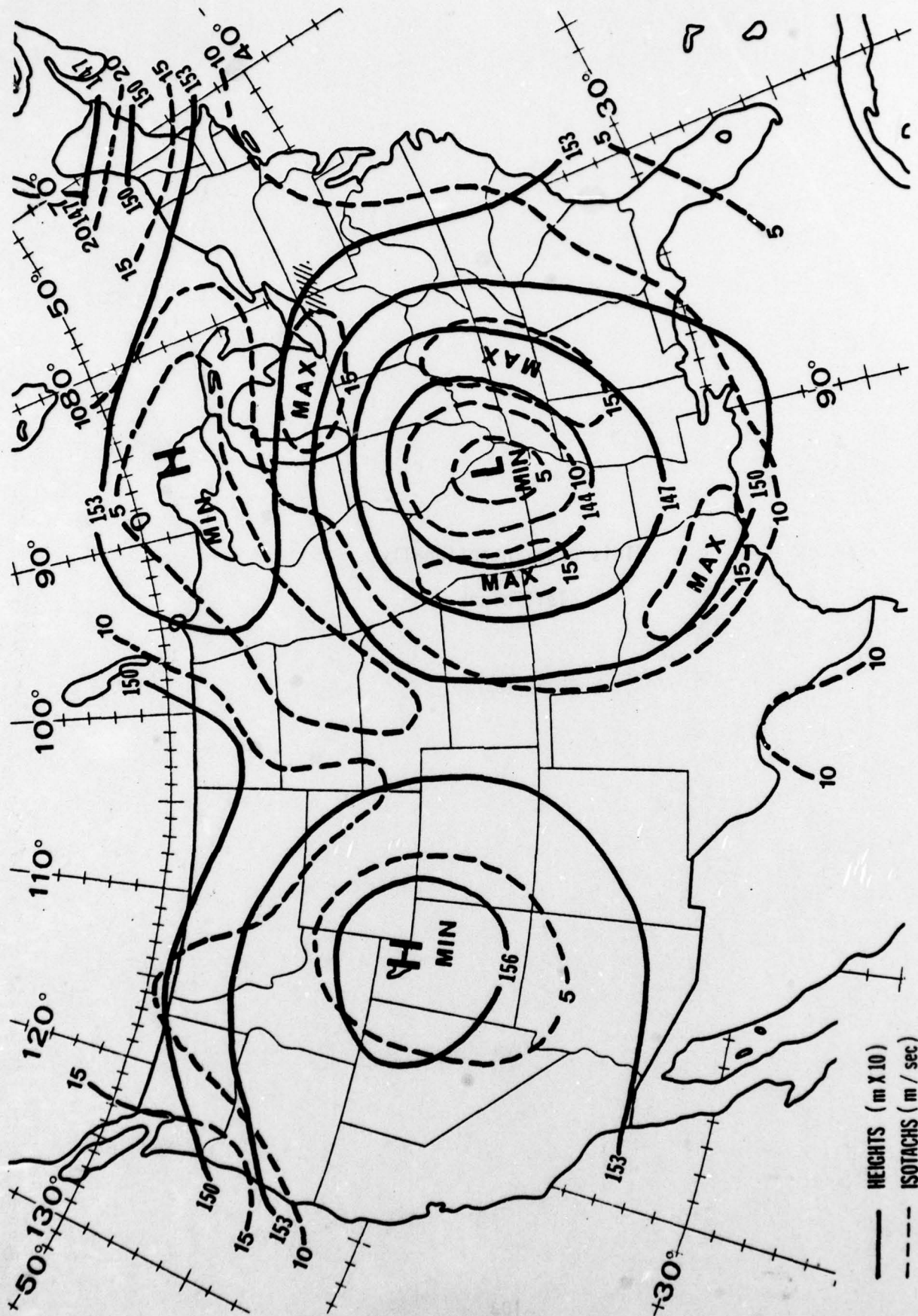


Figure 75. 850 mb HEIGHTS/ISOTACHS - 25 MAR 78 12Z ANALYSIS

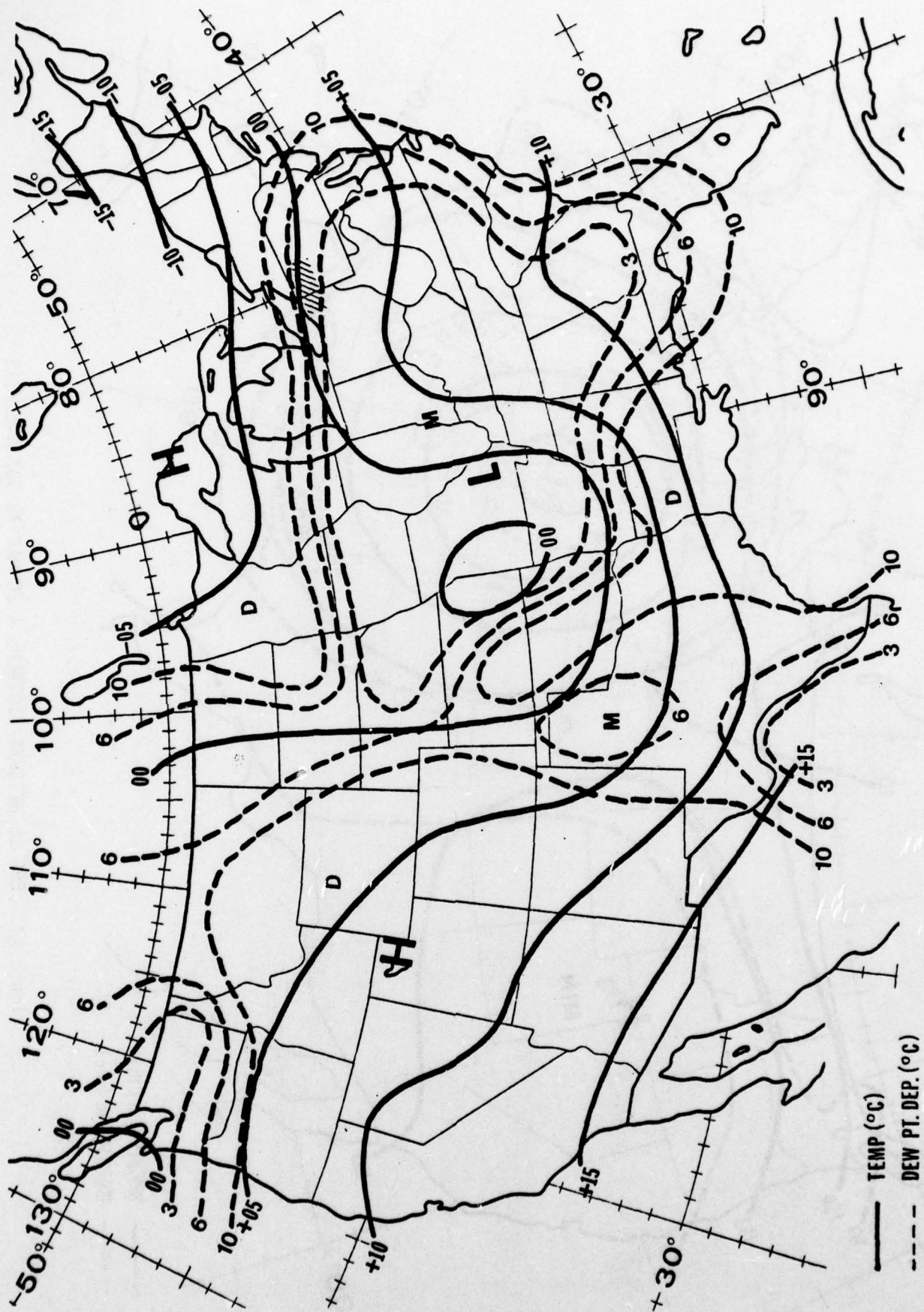


Figure 76. 850 mb TEMP./DEW PT. DEPRESSION - 25 MAR 78 12Z ANALYSIS

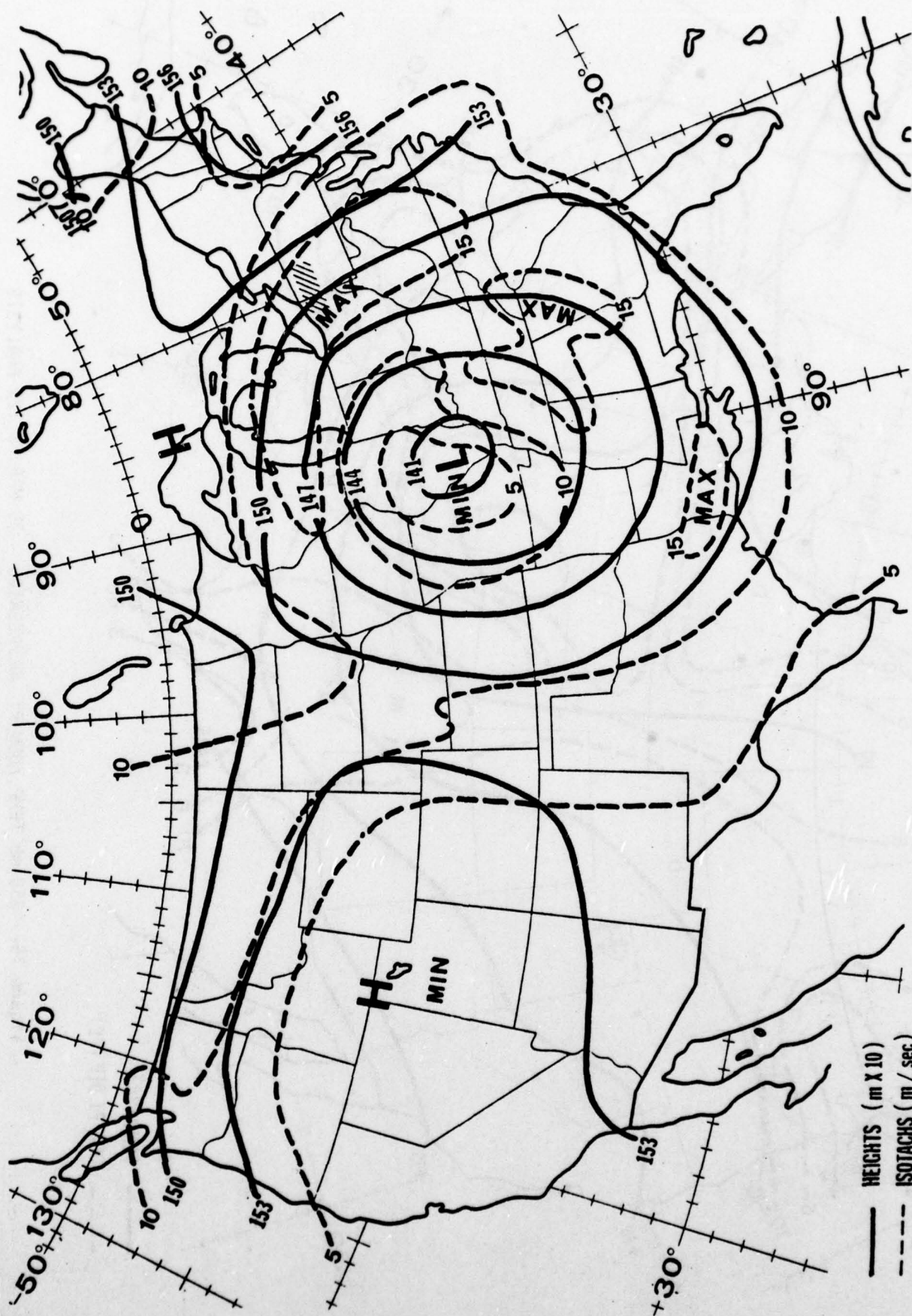


Figure 77. 850 mb HEIGHTS/ISOTACHS - 26 MAR 78 00Z ANALYSIS

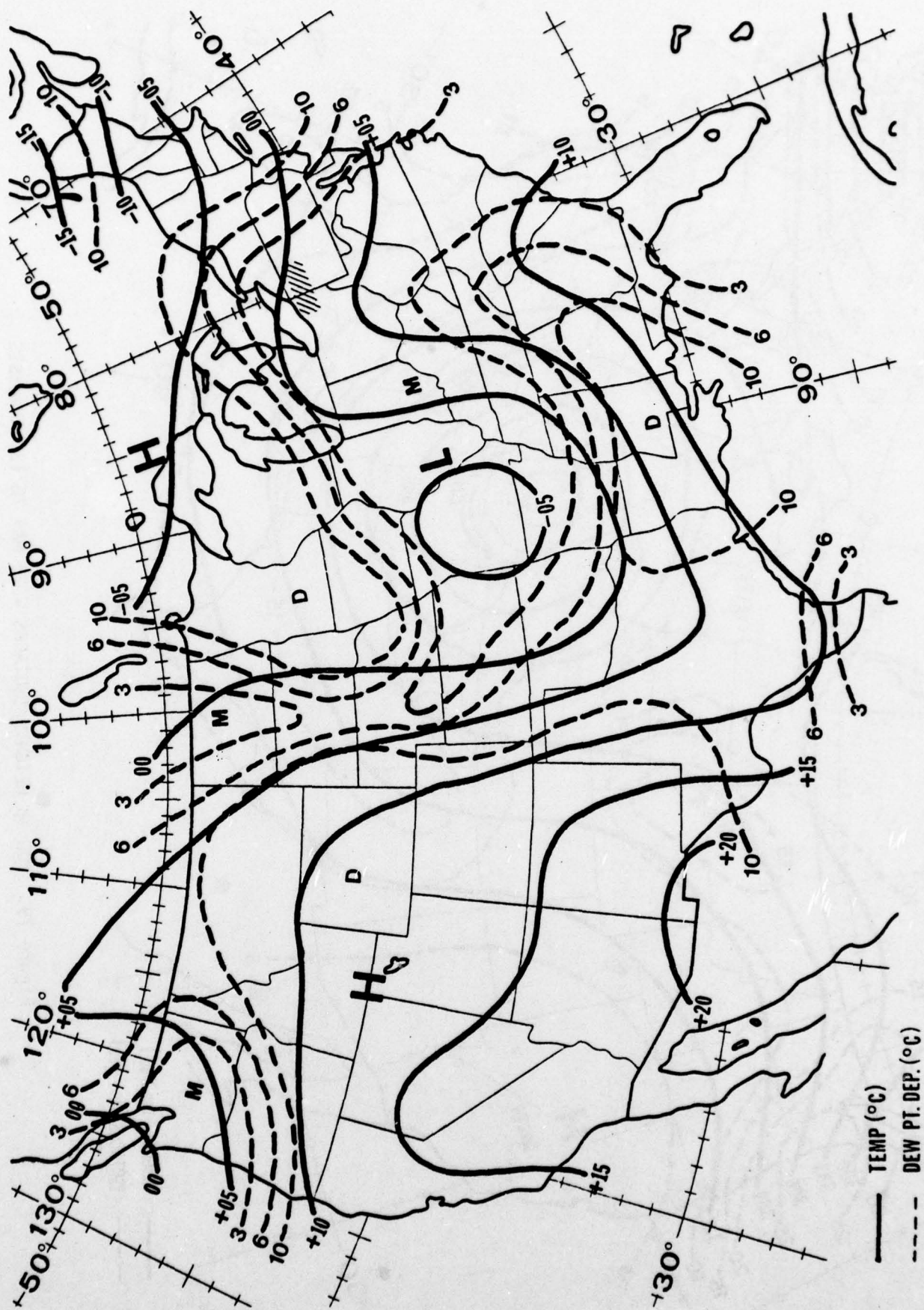


Figure 78. 850 mb TEMP./DEW PT. DEPRESSION - 26 MAR 78 00Z ANALYSIS

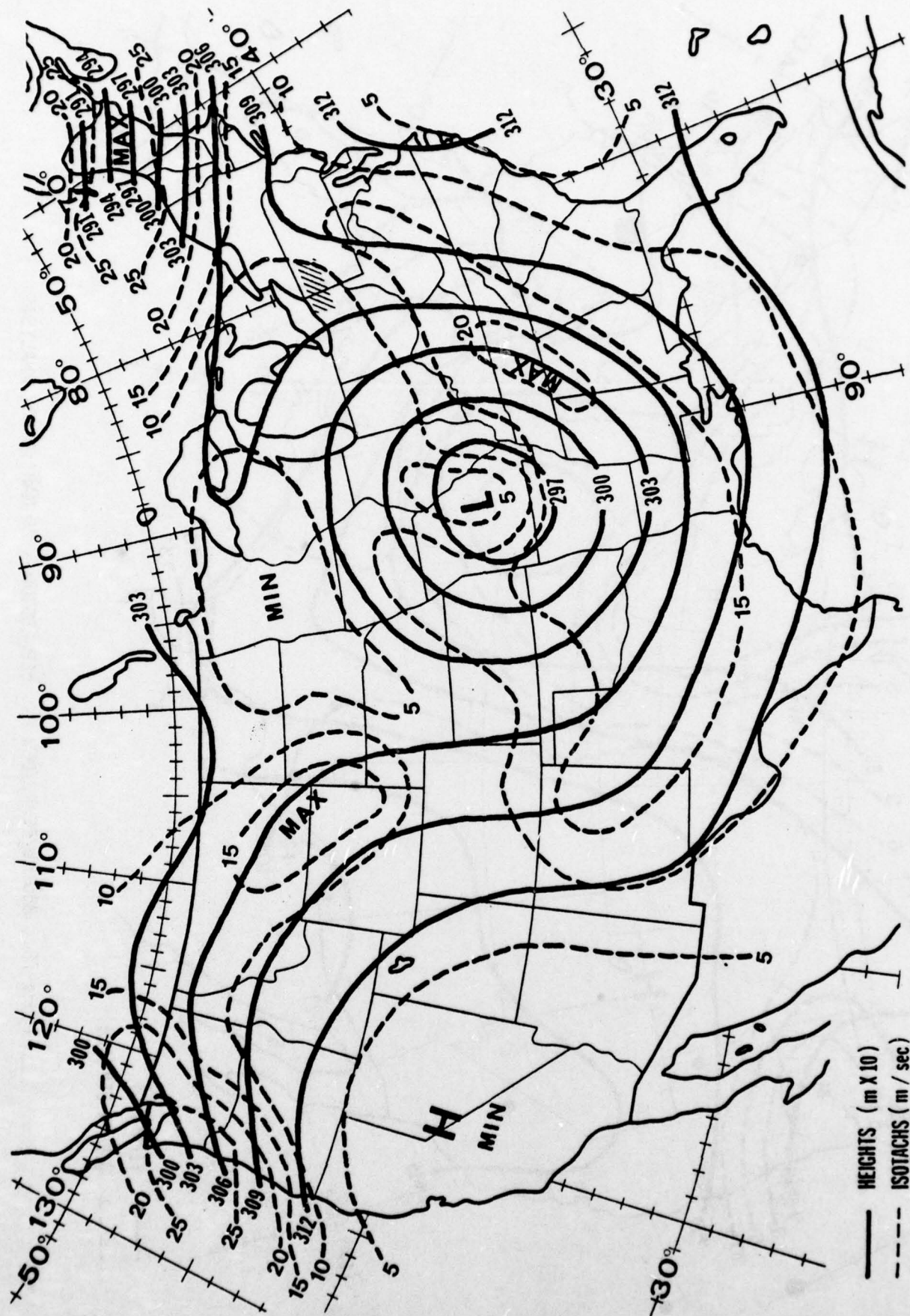


Figure 79. 700 mb HEIGHTS/ISOBARS - 25 MAR 78 12Z ANALYSIS

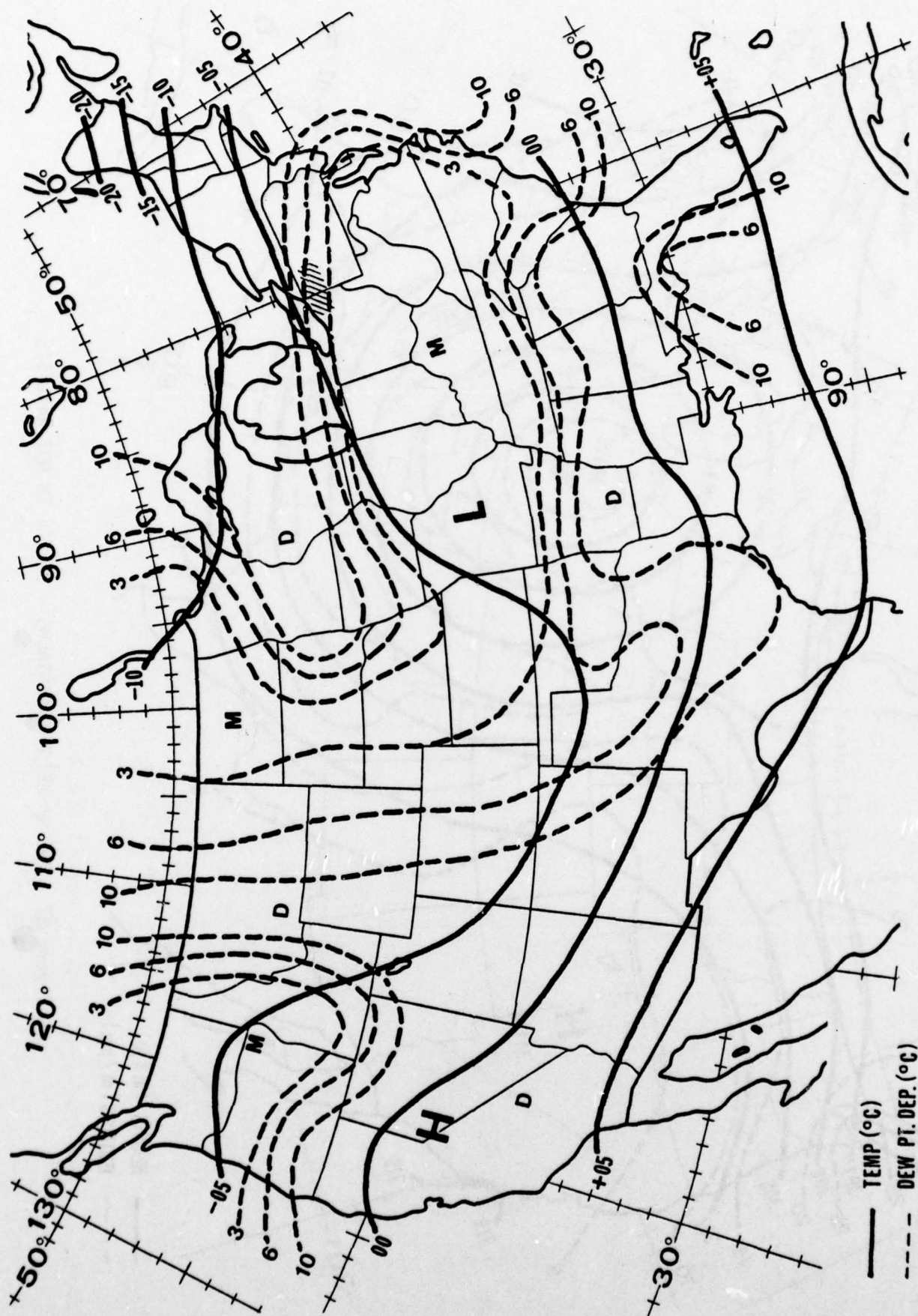


Figure 80. 700 mb TEMP./DEW PT. DEPRESSION - 25 MAR 78 12Z ANALYSIS

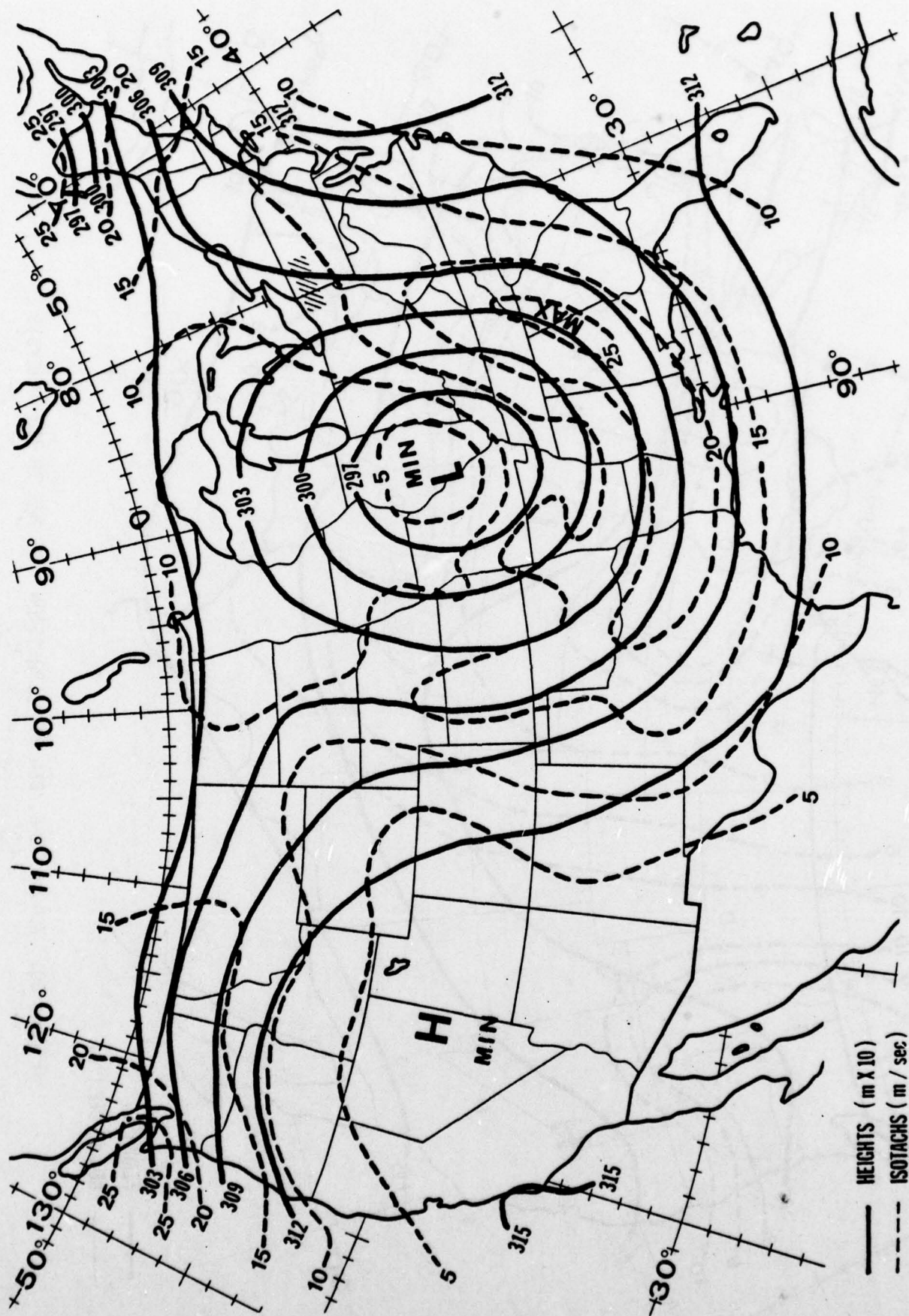


Figure 81. 700 mb HEIGHTS/ISOTACHS - 26 MAR 78 00Z ANALYSIS

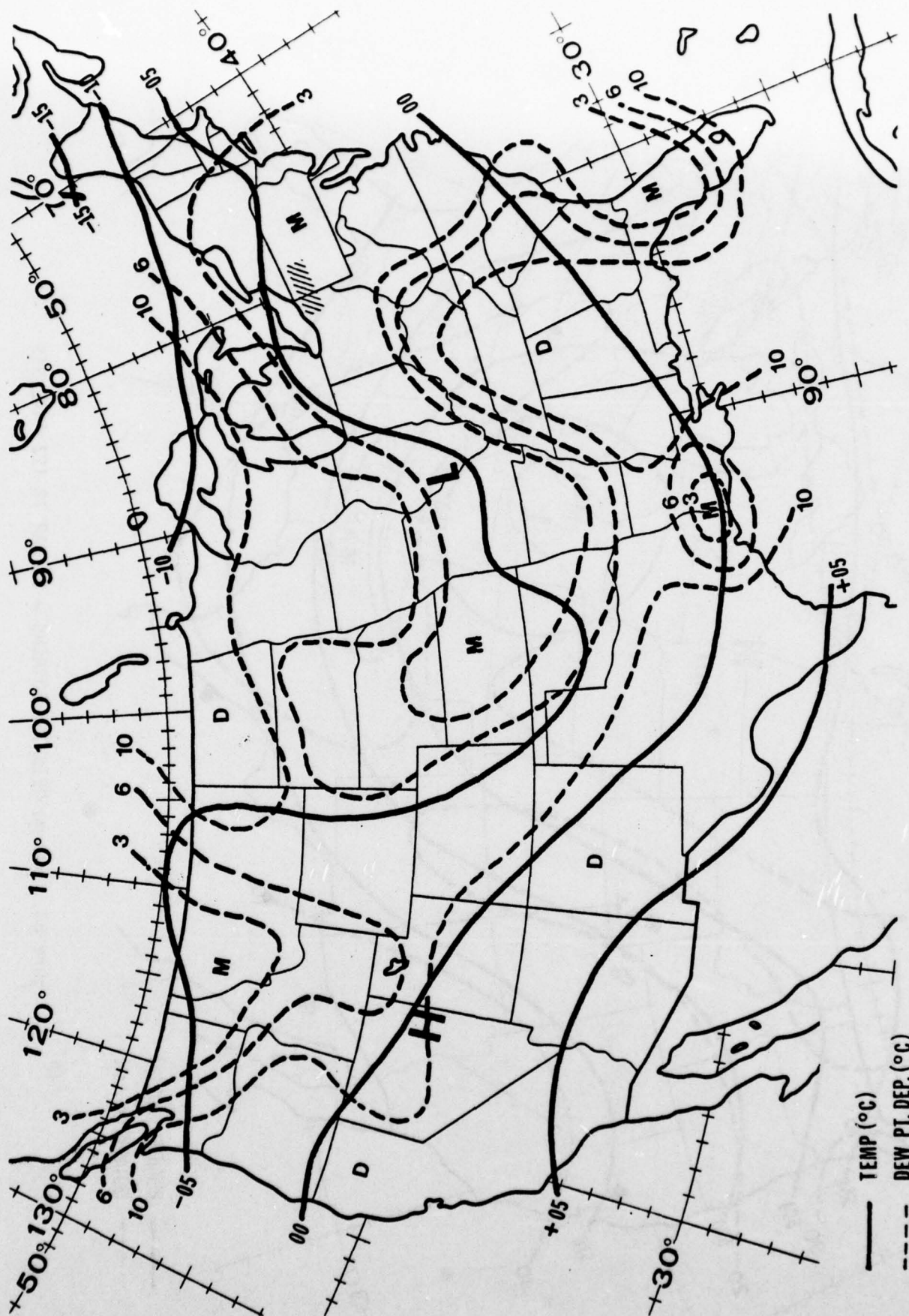


Figure 82. 700 mb TEMP./DEW PT. DEPRESSION - 26 MAR 78 00Z ANALYSIS

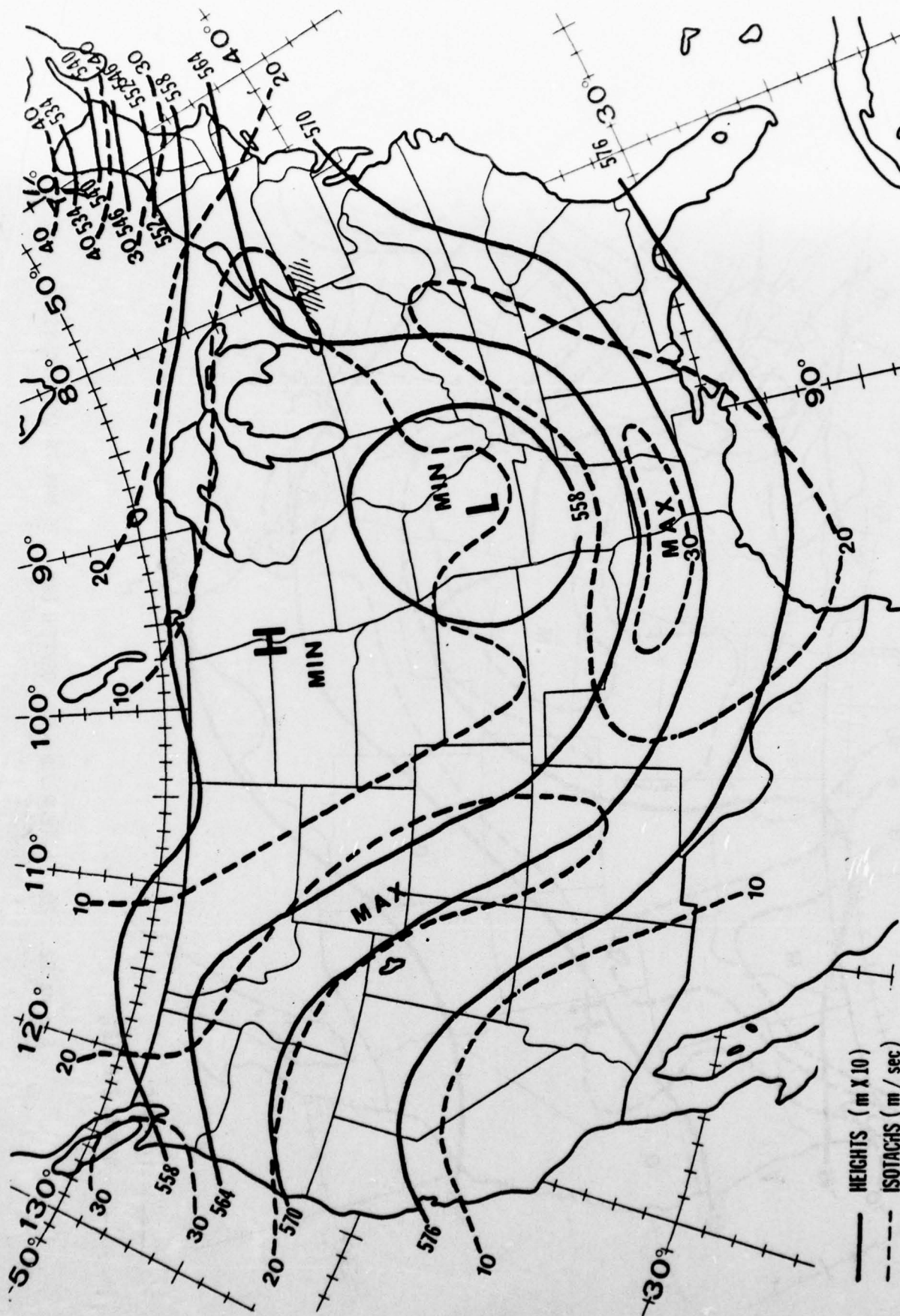


Figure 83. 500 mb HEIGHTS/ISOTACHS - 25 MAR 78 12Z ANALYSIS

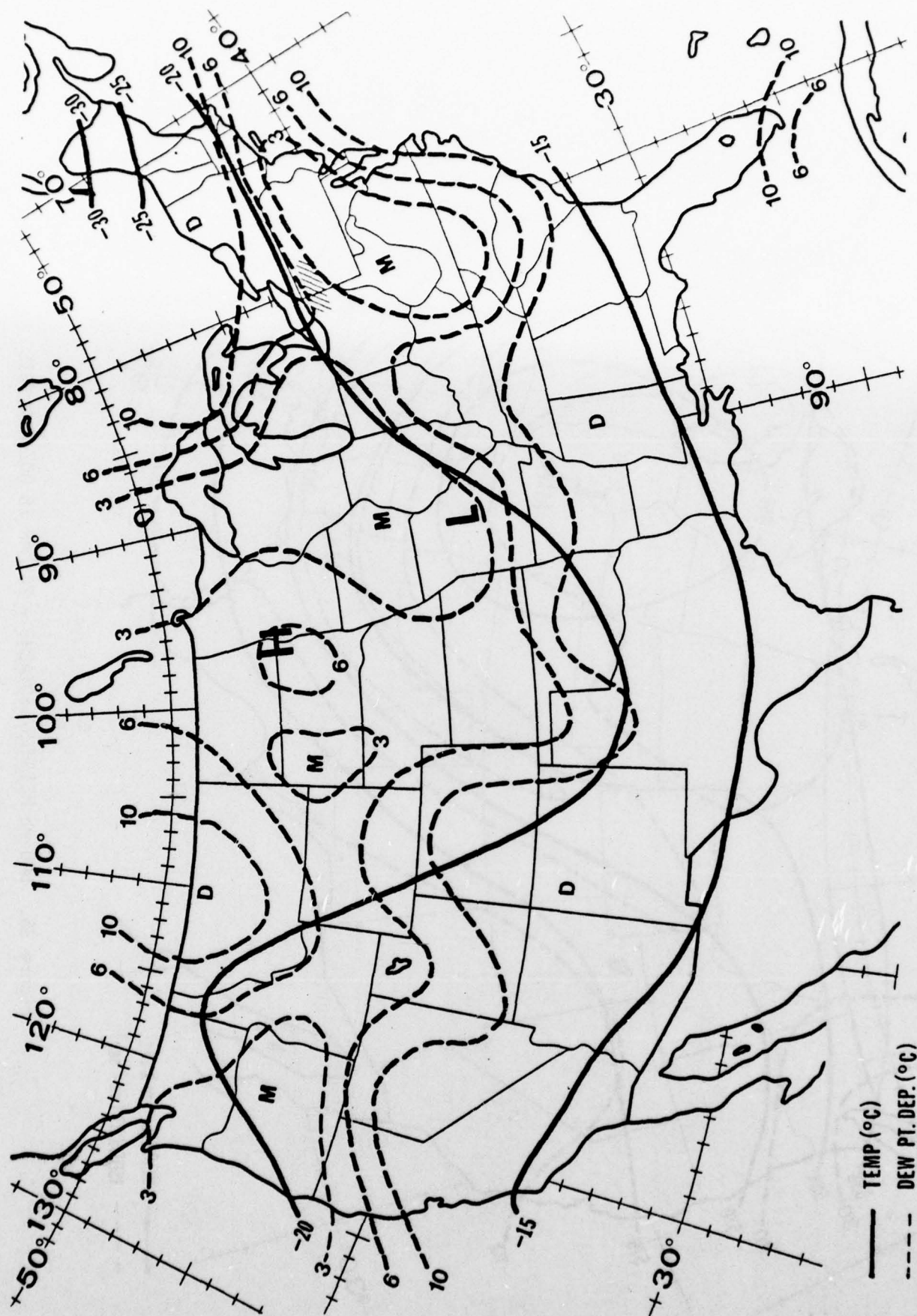


Figure 84. 500 mb TEMP./DEW PT. DEPRESSION - 25 MAR 78 12Z ANALYSIS

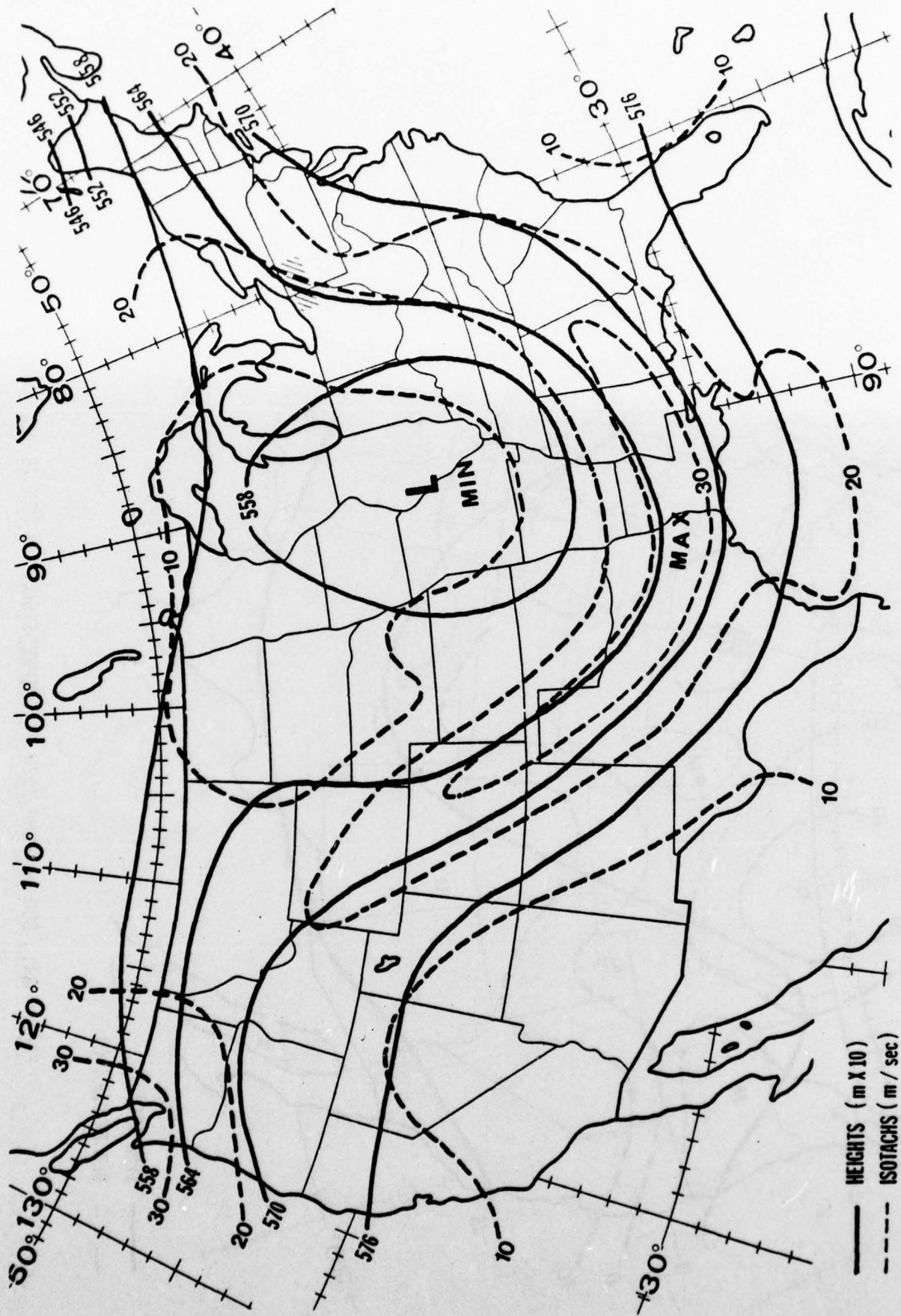


Figure 85. 500 mb HEIGHTS/ISOTACHS - 26 MAR 78 00Z ANALYSIS

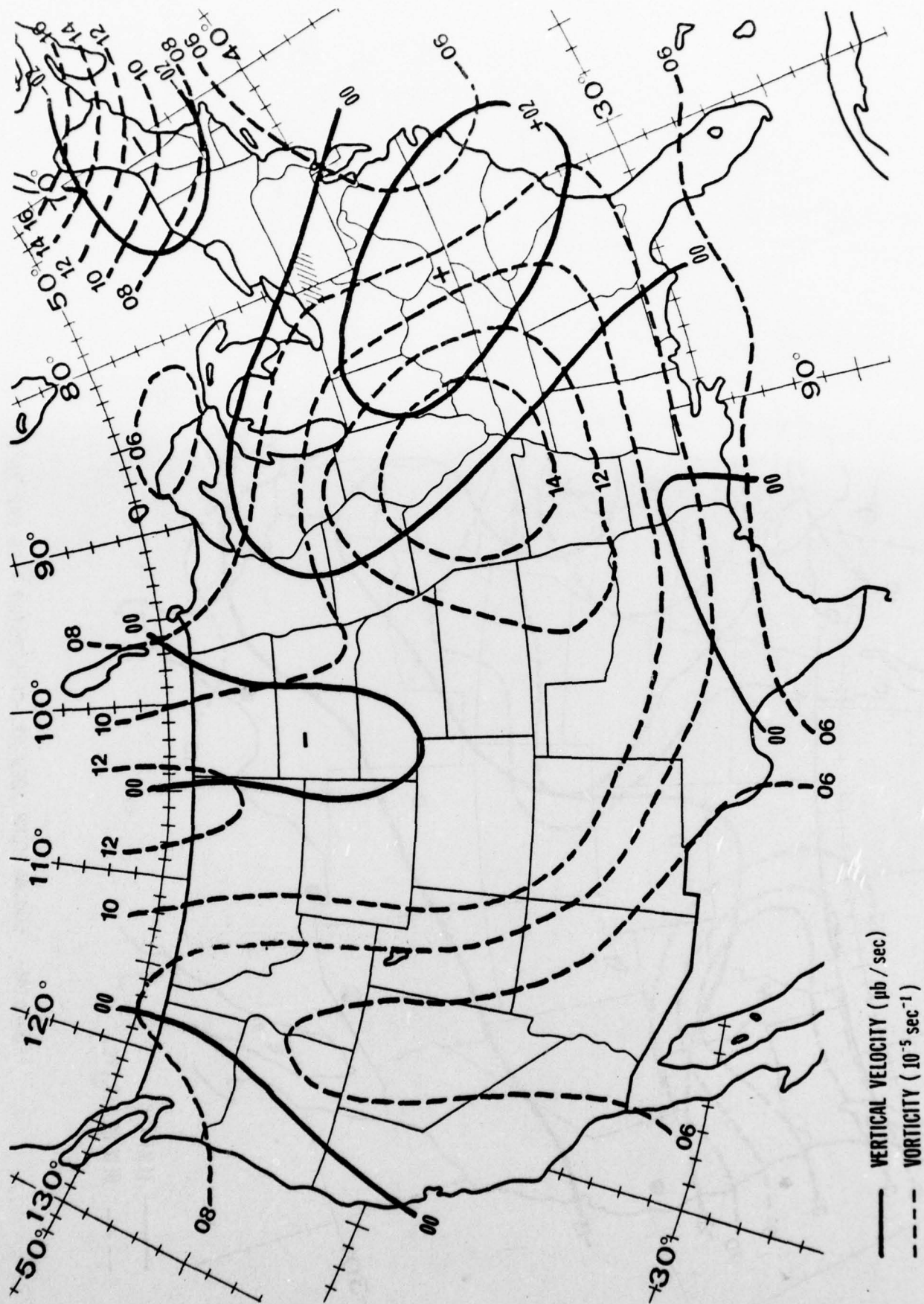


Figure 87. 500 mb VERTICAL VELOCITY/VORTICITY - 25 MAR 78 12Z ANALYSIS

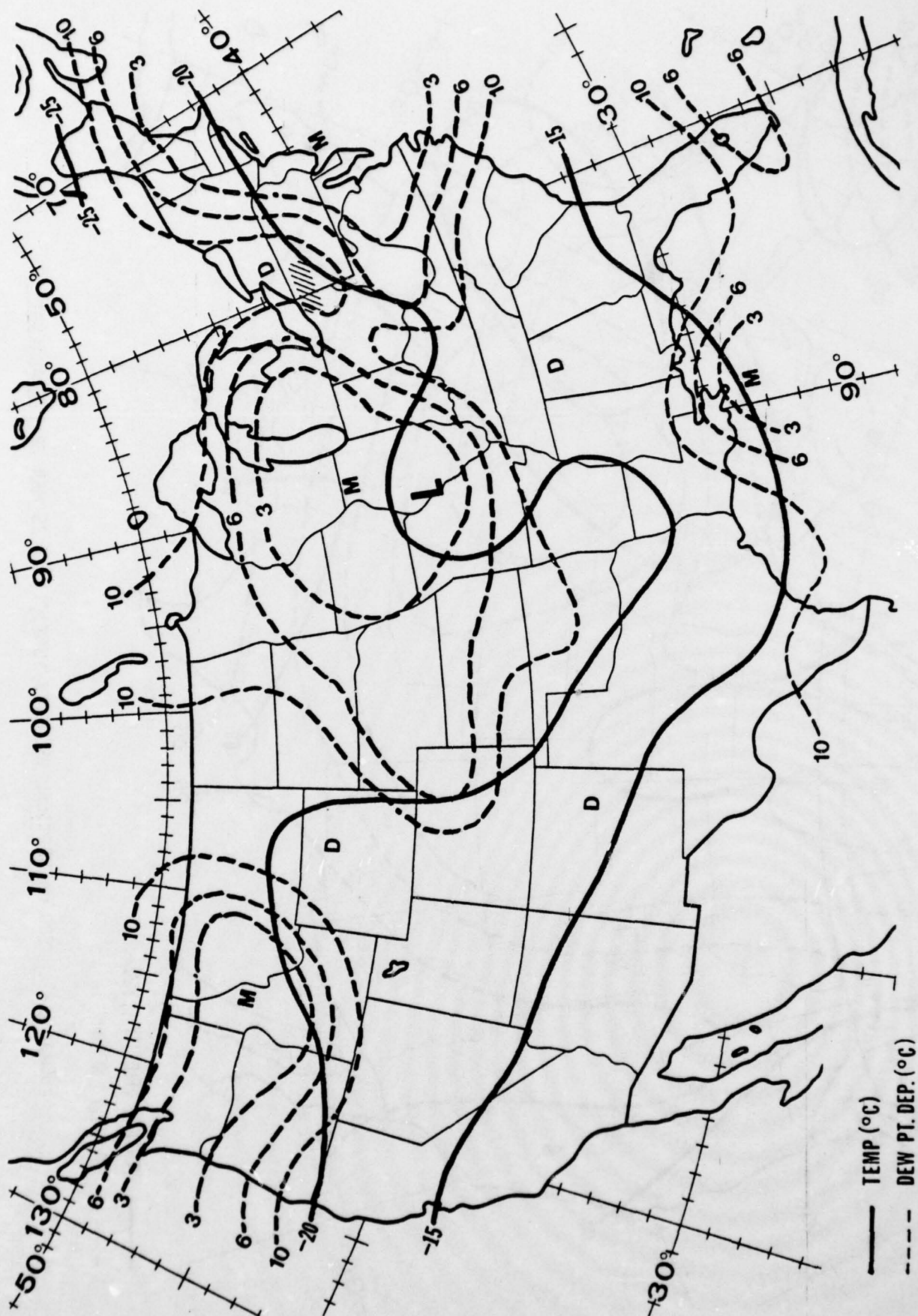


Figure 86. 500 mb TEMP./DEW PT. DEPRESSION - 26 MAR 78 00Z ANALYSIS

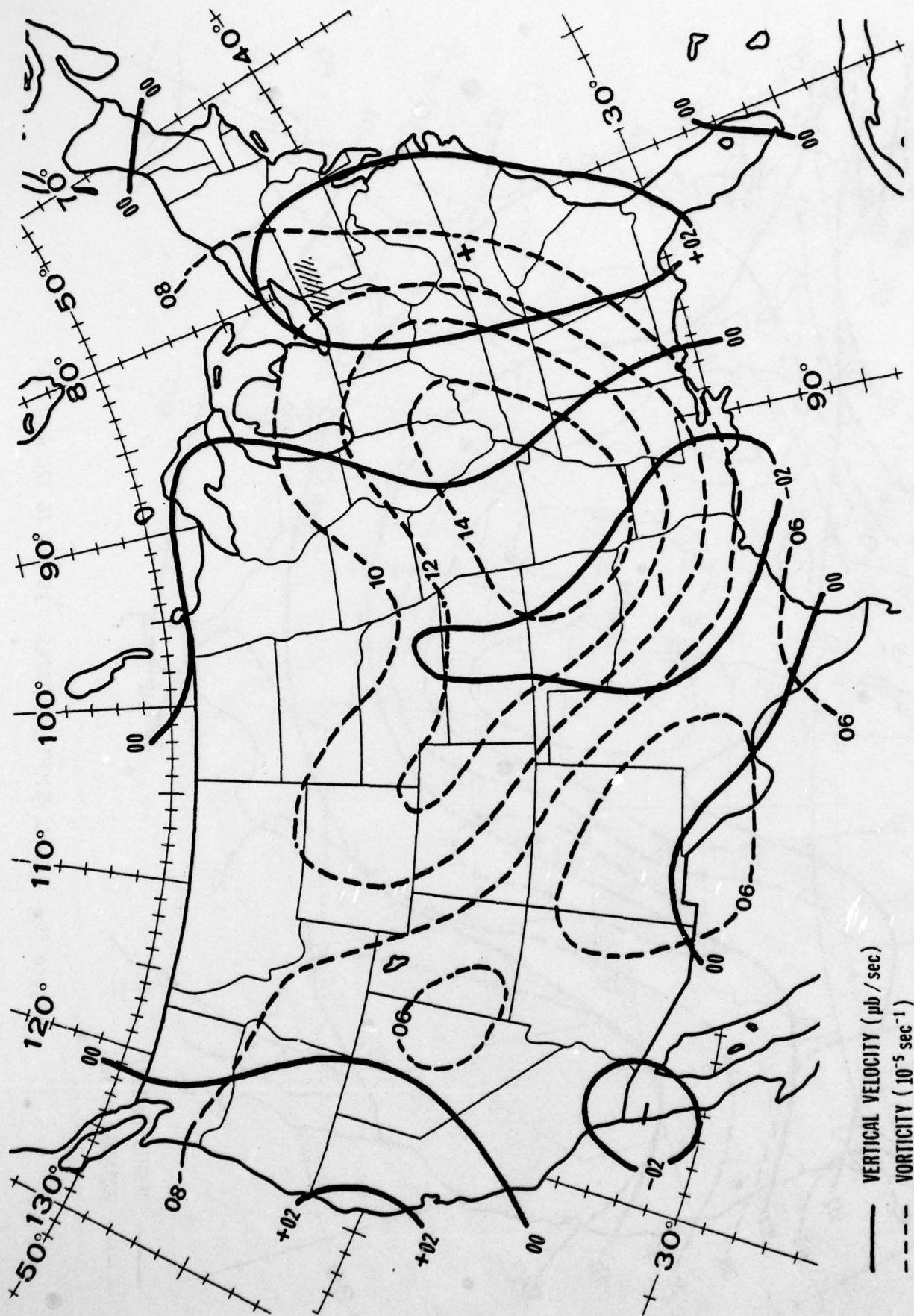


Figure 88. 500 mb VERTICAL VELOCITY/VORTICITY - 26 MAR 78 00Z ANALYSIS

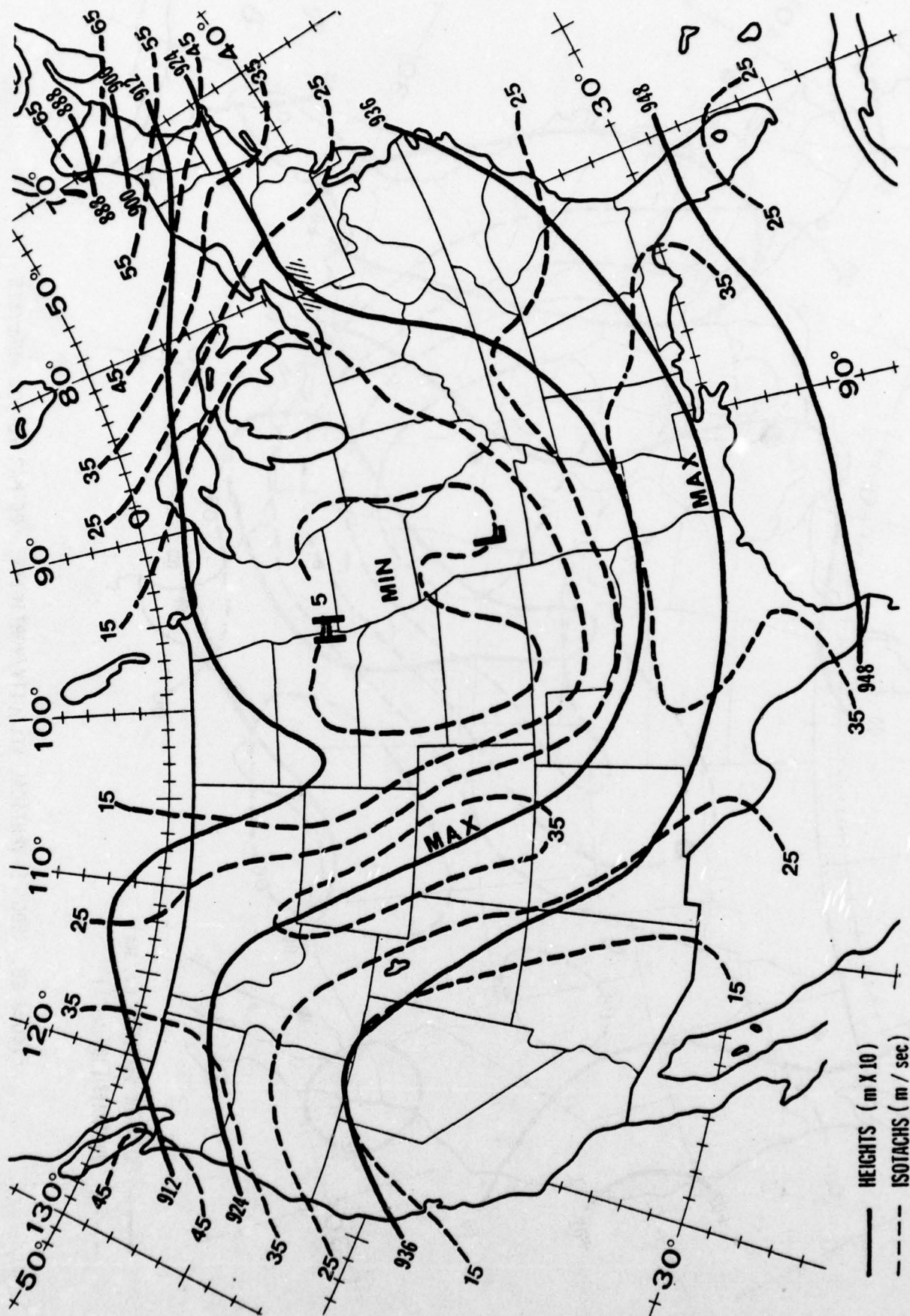


Figure 89. 300 mb HEIGHTS/ISOTACHS - 25 MAR 78 12Z ANALYSIS

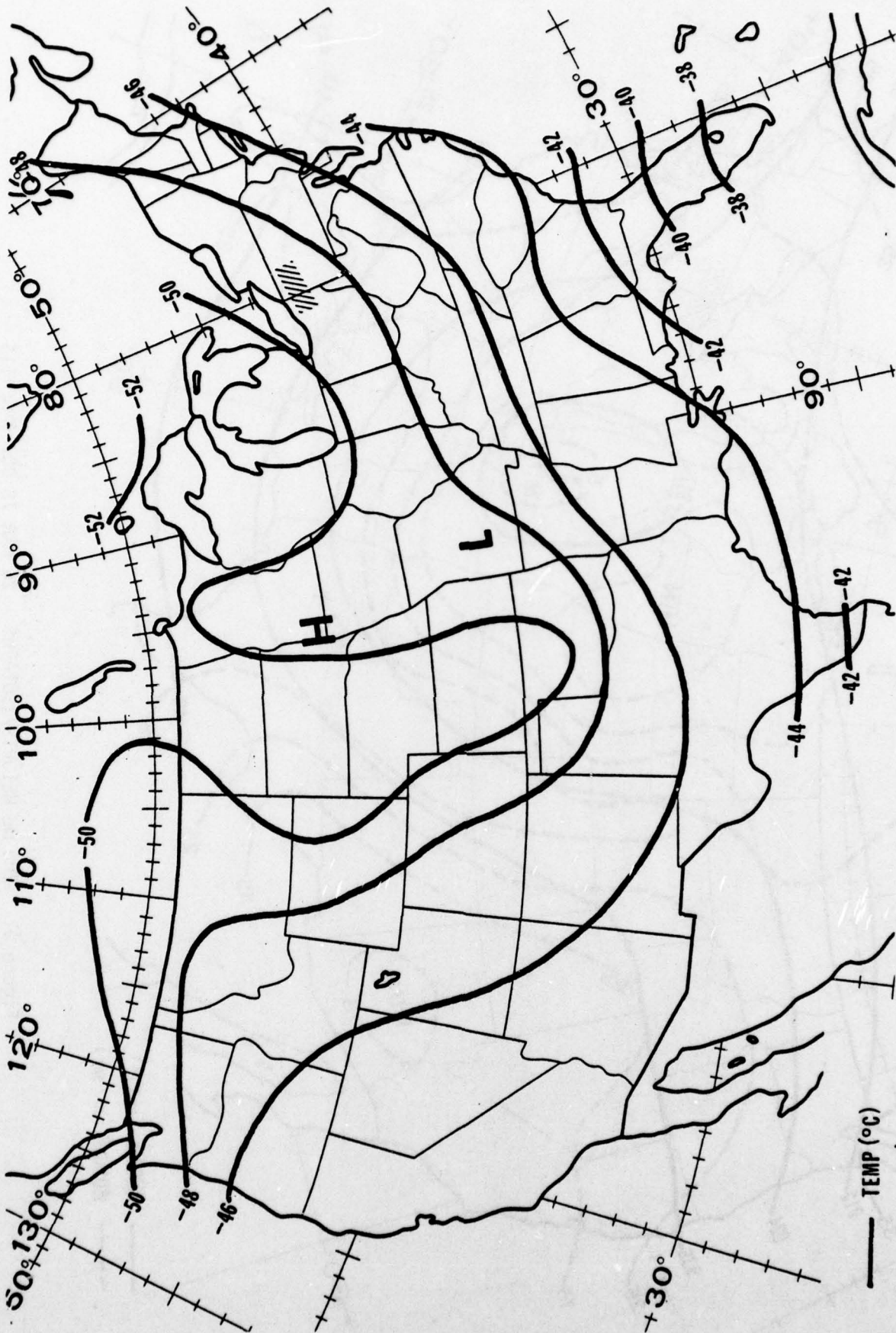


Figure 90. 300 mb TEMPERATURE - 25 MAR 78 12Z ANALYSIS

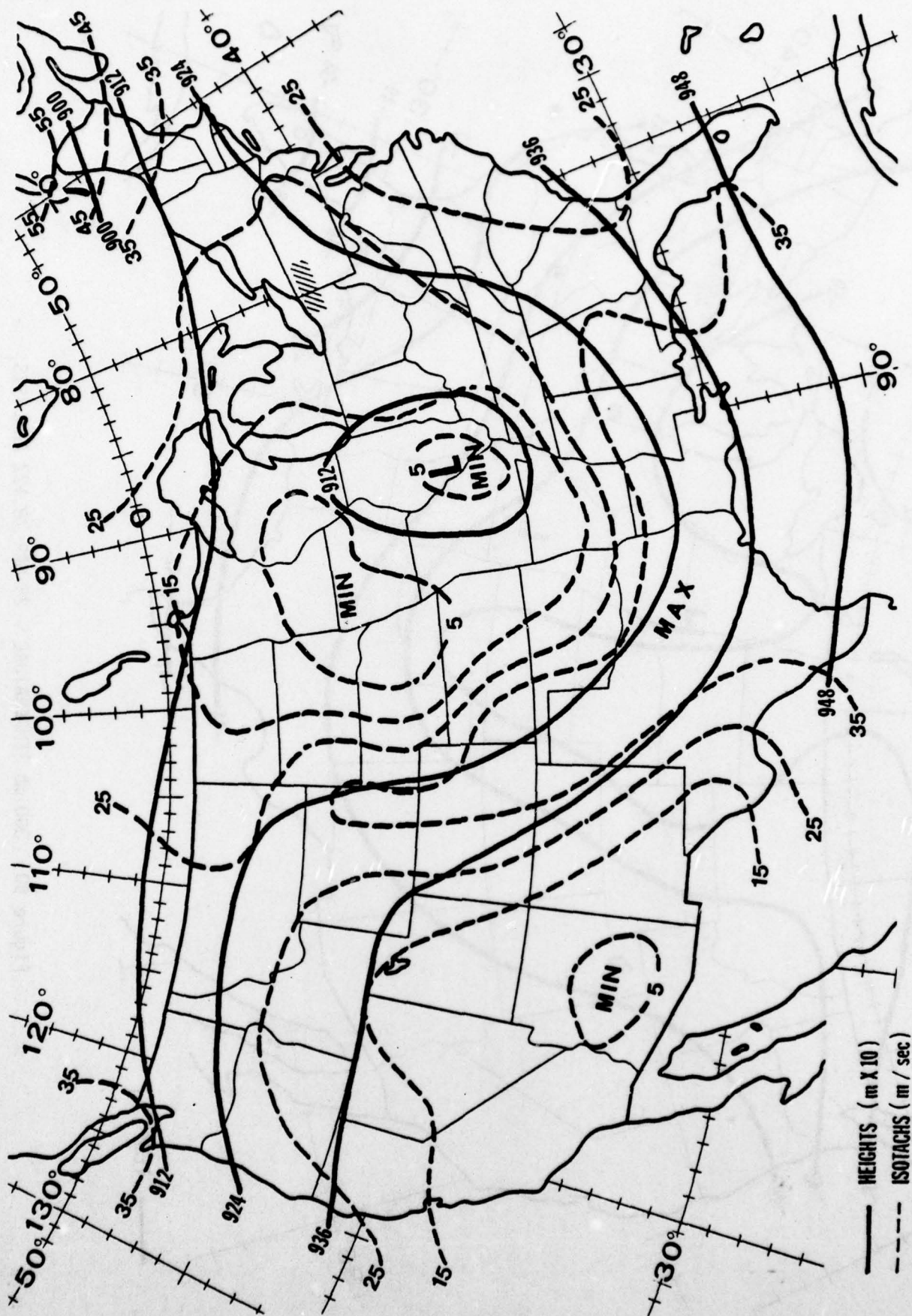


Figure 91. 300 mb HEIGHTS/ISOTACHS - 26 MAR 78 00Z ANALYSIS

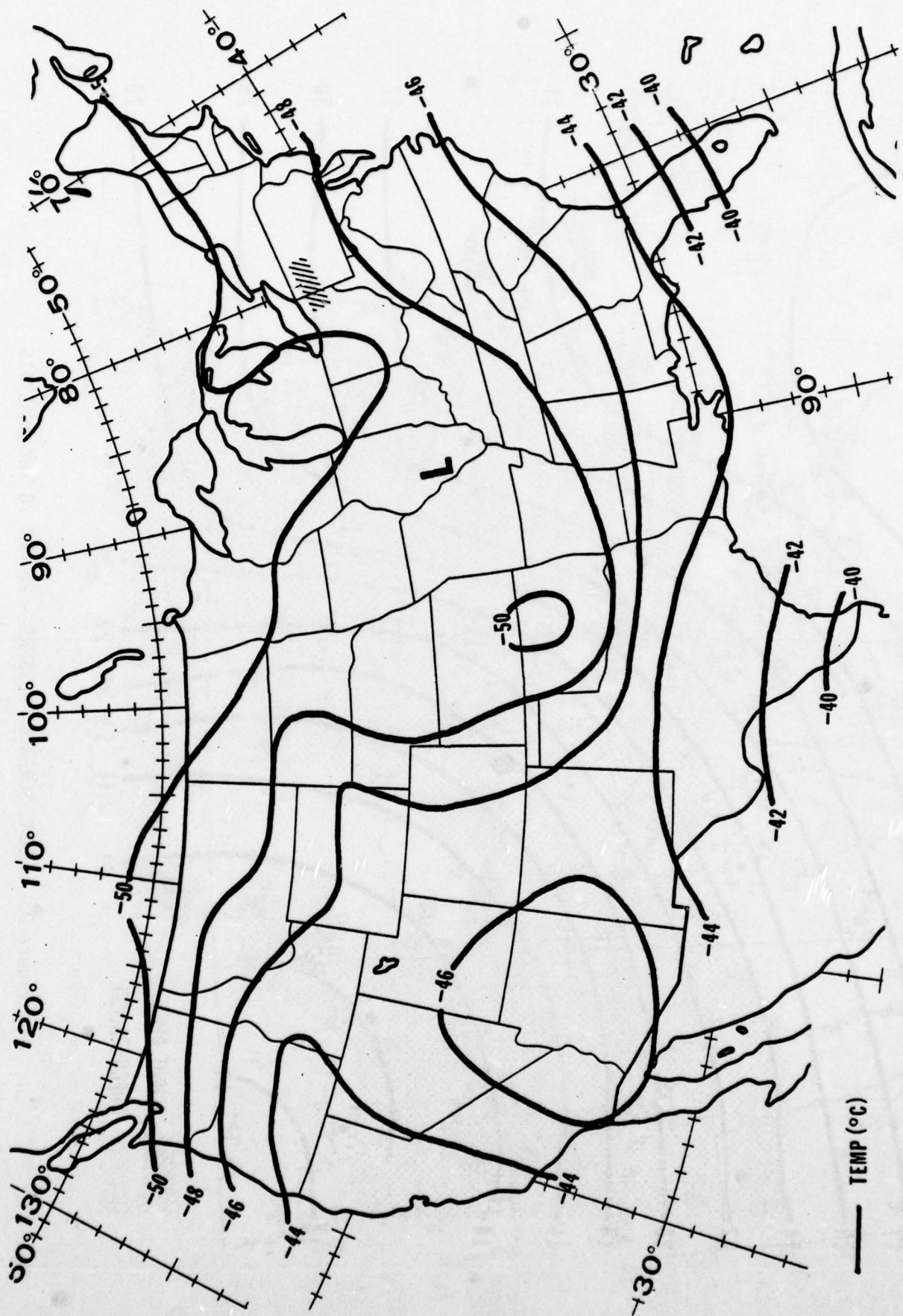


Figure 92. 300 mb TEMPERATURE - 26 MAR 78 00Z ANALYSIS

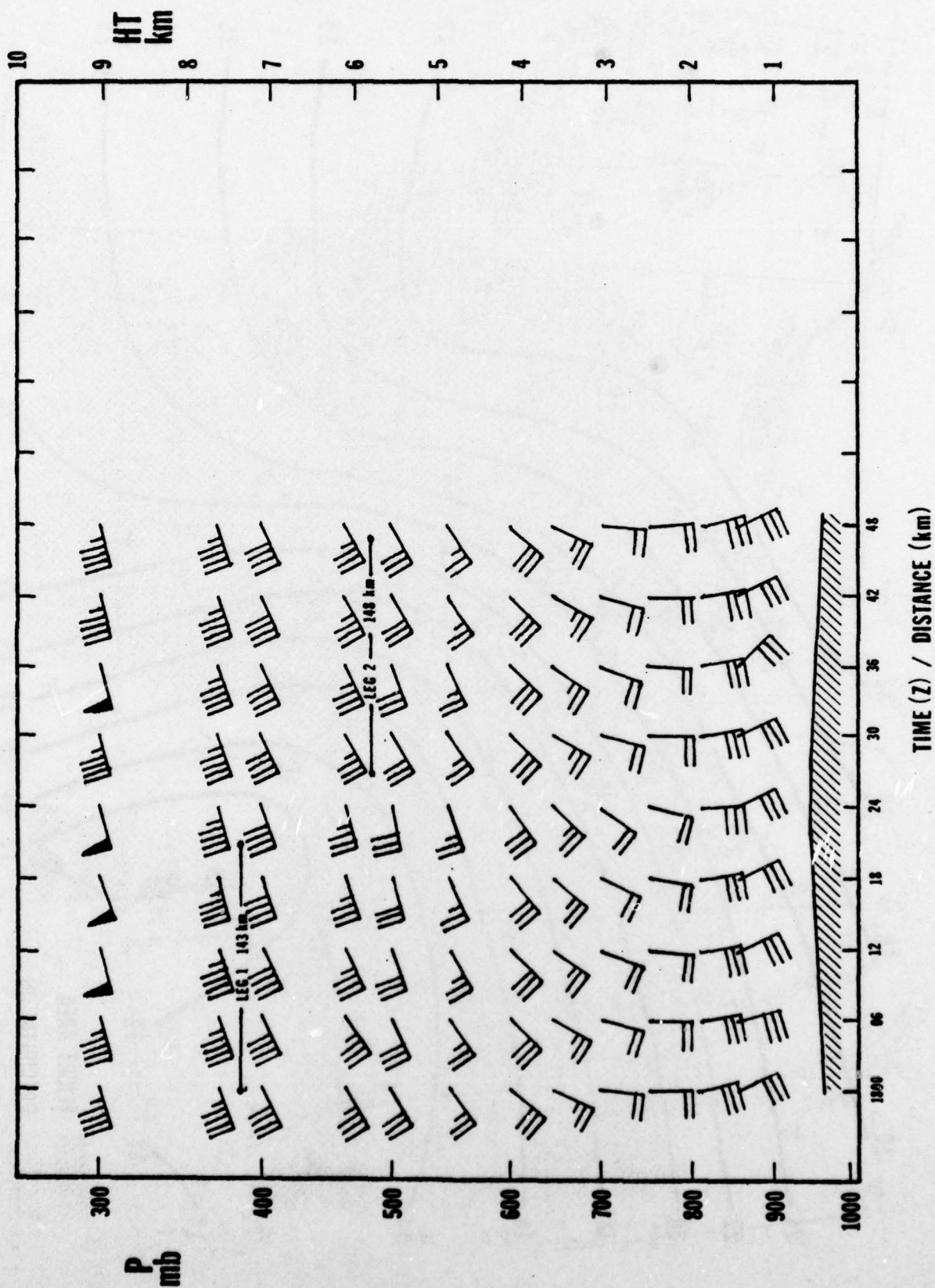


Figure 95. WIND CROSS-SECTION LEGS 1 AND 2 - 25 MAR 78 ANALYSIS

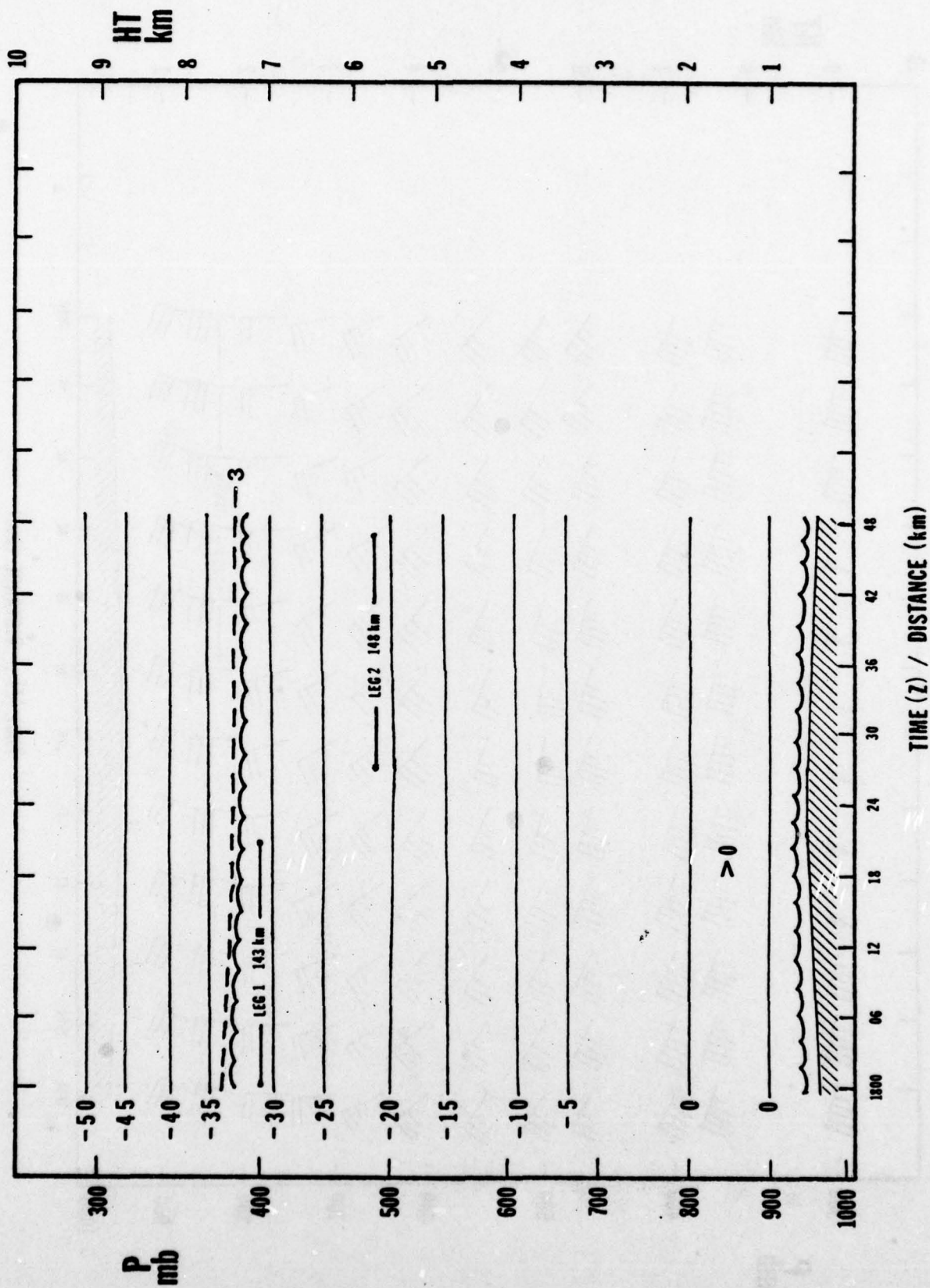


Figure 96. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 1 AND 2 - 25 MAR 78 ANALYSIS

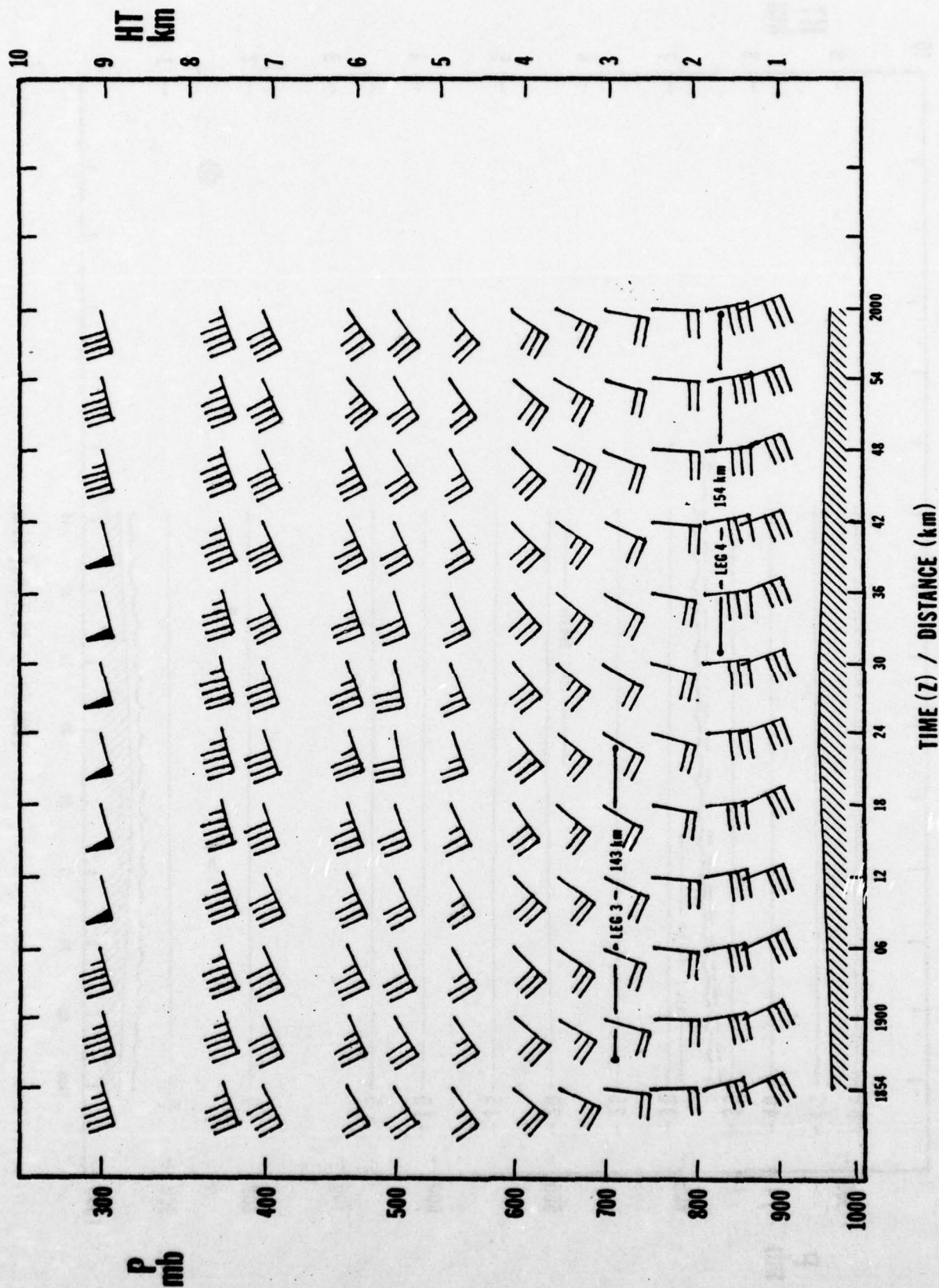


Figure 97. WIND CROSS-SECTION LEGS 3 AND 4 - 25 MAR 78 ANALYSIS

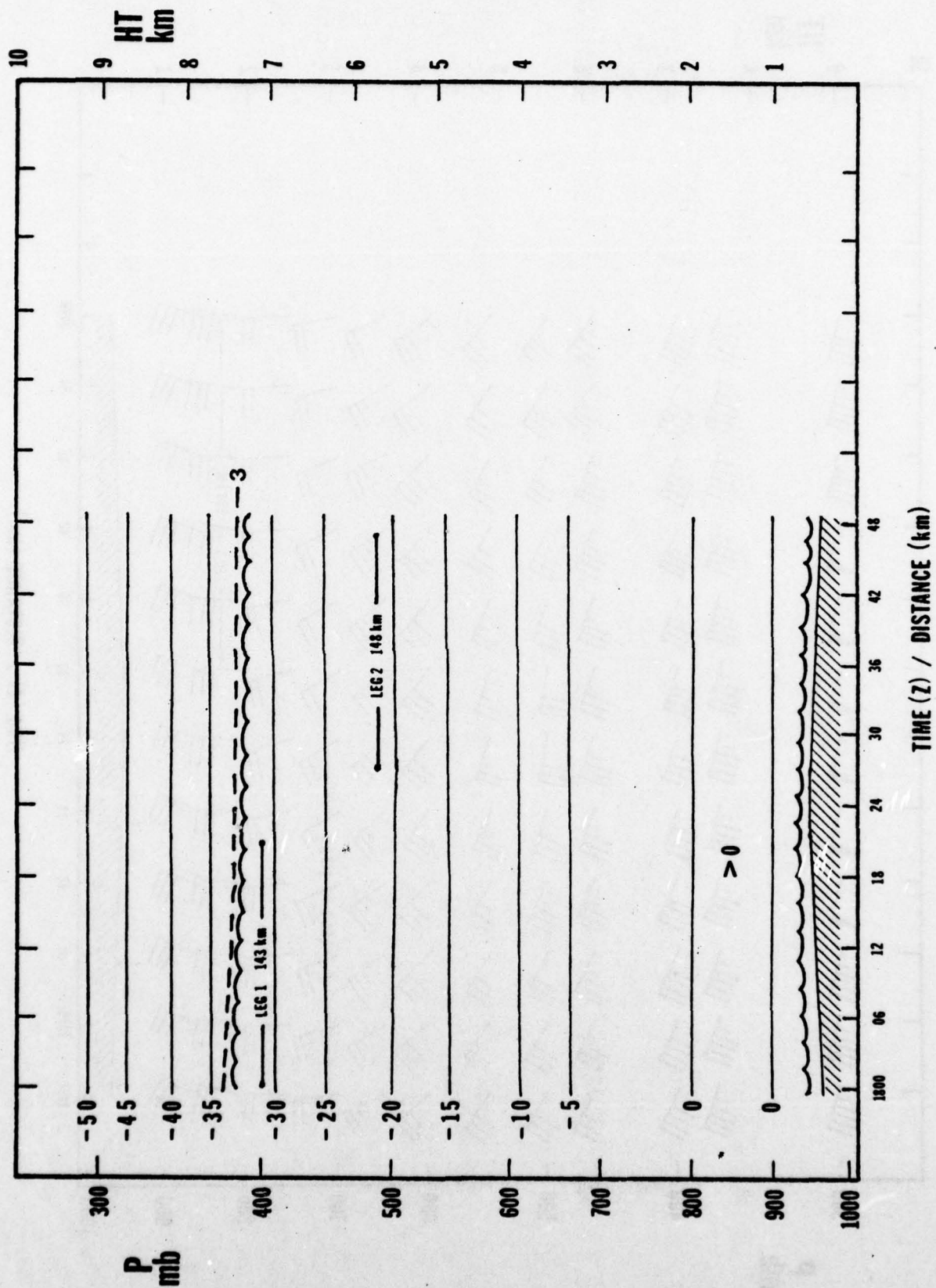


Figure 96. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 1 AND 2 - 25 MAR 78 ANALYSIS

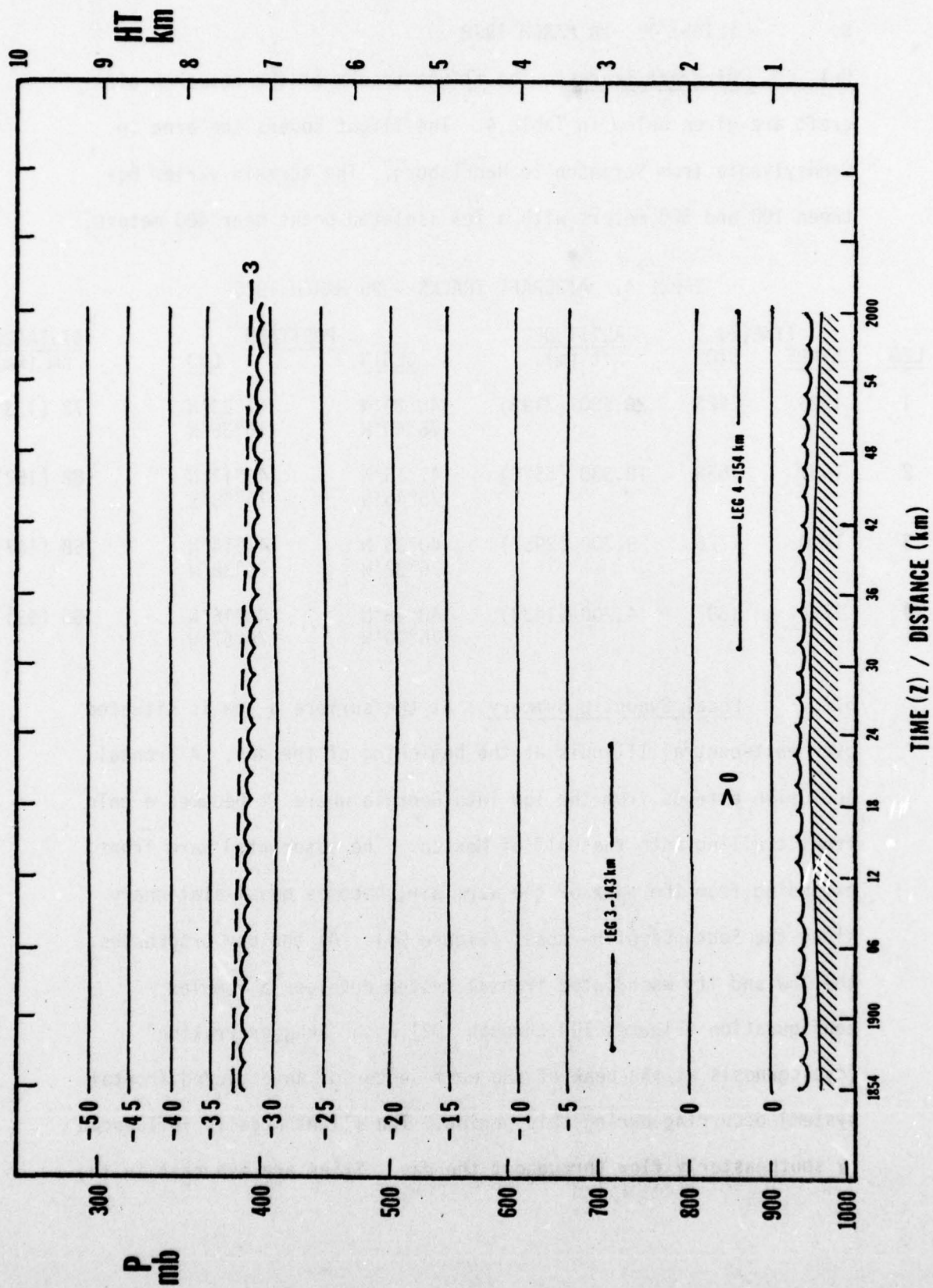


Figure 98. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 3 AND 4 - 25 MAR 78 ANALYSIS

5. FLIGHT 4 26 MARCH 1978

5.1 Aircraft Tracks. The flight tracks of the research aircraft are given below in Table 4. The flight covers the area in Pennsylvania from Scranton to Harrisburg. The terrain varies between 100 and 300 meters with a few isolated peaks near 480 meters.

TABLE 4. AIRCRAFT TRACKS - 26 MARCH 1978

LEG	TIME(Z)		ALTITUDE ft (m)	POSITION		DISTANCE nm (km)
	START	STOP		BEGIN	END	
1	1606	1623	23,600 (7193)	40°29'N 76°40'W	41°23'N 75°36'W	72 (133)
2	1631	1658	18,300 (5578)	41°16'N 75°45'W	40°17'N 76°58'W	82 (152)
3	1710	1726	9,700 (2957)	40°36'N 76°32'W	41°14'N 75°38'W	58 (107)
4	1734	1807	4,700 (1433)	40°48'N 76°10'W	40°16'N 76°57'W	50 (93)

5.2 Local Synoptic Summary. At the surface a low is situated over east-central Illinois at the beginning of the day. A frontal occlusion extends from the low into Georgia where it becomes a cold front trailing into the Gulf of Mexico. The associated warm front, extending from the apex of the warm air, becomes quasi-stationary along the South Carolina coast (Figure 99). As the day progresses, the low and its associated frontal system develops a complex configuration (Figures 100 through 102) with "Skaggerarraking" (cyclogenesis at the peak of the warm sector of an occluded frontal system) occurring during this period. The flight area is influenced by southeasterly flow throughout the day. Skies are overcast in the

flight area as a result of moist air over running the cold air mass behind the warm front (Figures 103 through 106).

At 850 mb, the low centered over southern Illinois and Indiana dominates the entire eastern section of the United States (Figure 107). This low extends vertically through 300 mb. Warm air exists in advance of the low with cold air behind. A broad area of moist air at 850 mb accompanies the low and covers the flight area (Figure 108). The flight area remains under the influence of moist southerly flow with an area of $20\text{-}25 \text{ msec}^{-1}$ winds moving just to the east of the flight area by the end of the day (Figures 109 and 110).

The low at 700 mb moves eastward from southern Illinois and fills slightly. An area of 20 msec^{-1} winds passes over the flight area during the day (Figure 111 and 113). Relatively warm air lies over the flight area at this level accompanied by a wide band of moisture (Figures 112 and 114).

At 500 mb southerly flow exists over the flight area as the low moves slowly over southern Indiana. Warm moist air ahead of the low covers the flight area during the period of the flight (Figures 115 through 118). Upward vertical motion exists over the flight area at 500 mb while the vorticity increases slightly during the day (Figures 119 and 120).

The 300 mb level shows southwesterly flow over the flight area throughout the day (Figures 121 and 123). There is a slight increase in temperature at this level as the day progresses (Figures

122 and 124).

The local surface pressure chart shows the flight area under the influence of moist easterly flow as the warm front lying along the Atlantic coast moves inland toward the flight area (Figures 125 and 126). Rain and frozen precipitation exist over the flight zone and the surrounding area. Surface temperatures are at or slightly above freezing.

The vertical cross-sections (Figures 127 through 130) show southeasterly flow below 900 mb becoming southerly and then southwesterly from 850 mb through 300 mb. Temperatures decrease slightly toward the northeast end of the flight track at all levels. A deep moist layer exists from the surface to between 7.5 and 7.8 km. Clouds are layered throughout the moist zone with intermittent solid cumuliform cells. Cloud bases average 160 meters above the ground at the southwest end of the tracks to 360 meters above the ground at the northeast end.

The tropopause averages 11.3 km over the flight area sloping upward slightly toward the northeast. Minimum temperatures are near -63°C . No significant changes occur at the tropopause level over the duration of the flight.

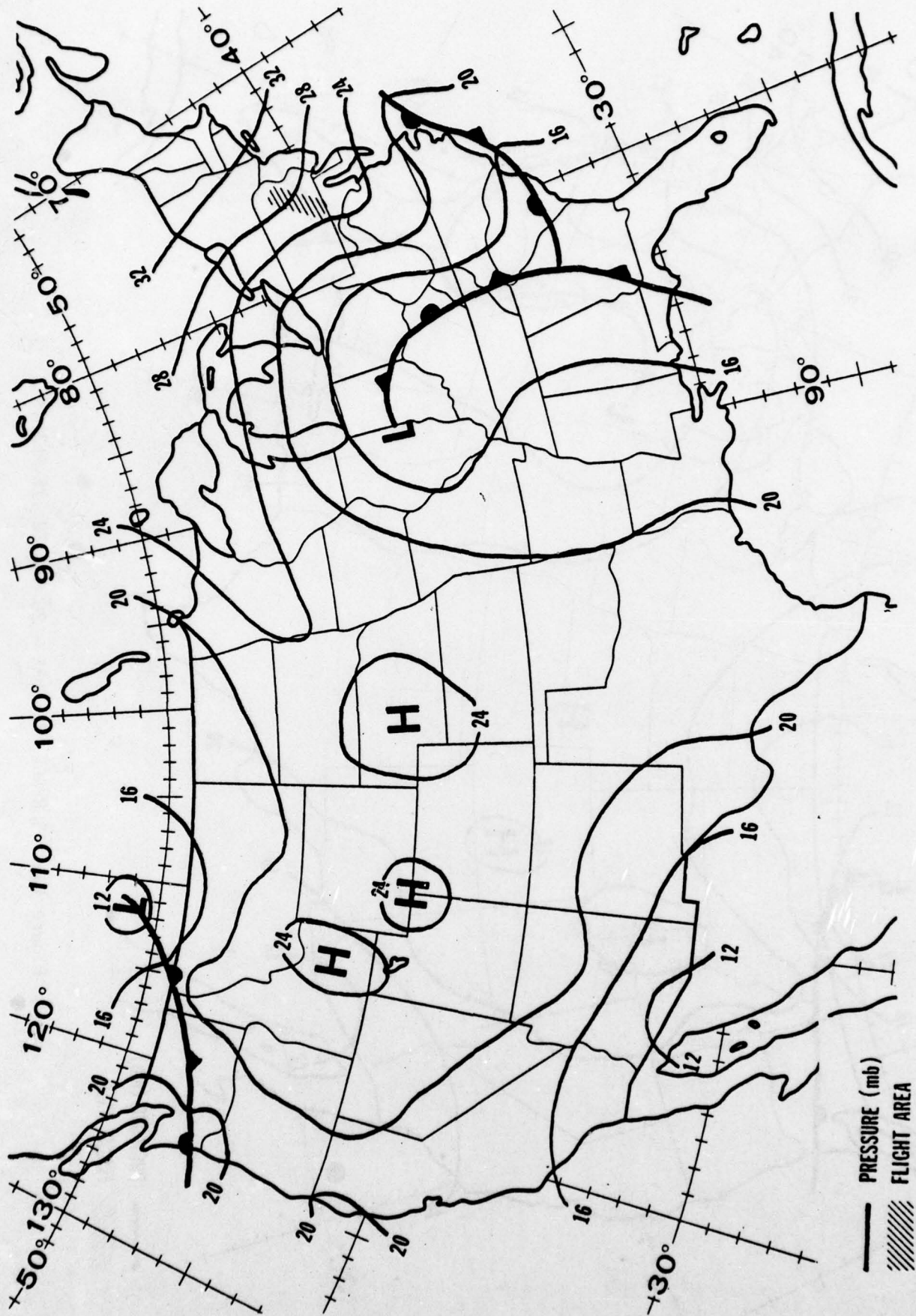


Figure 99. SURFACE PRESSURE - 26 MAR 78 06Z ANALYSIS

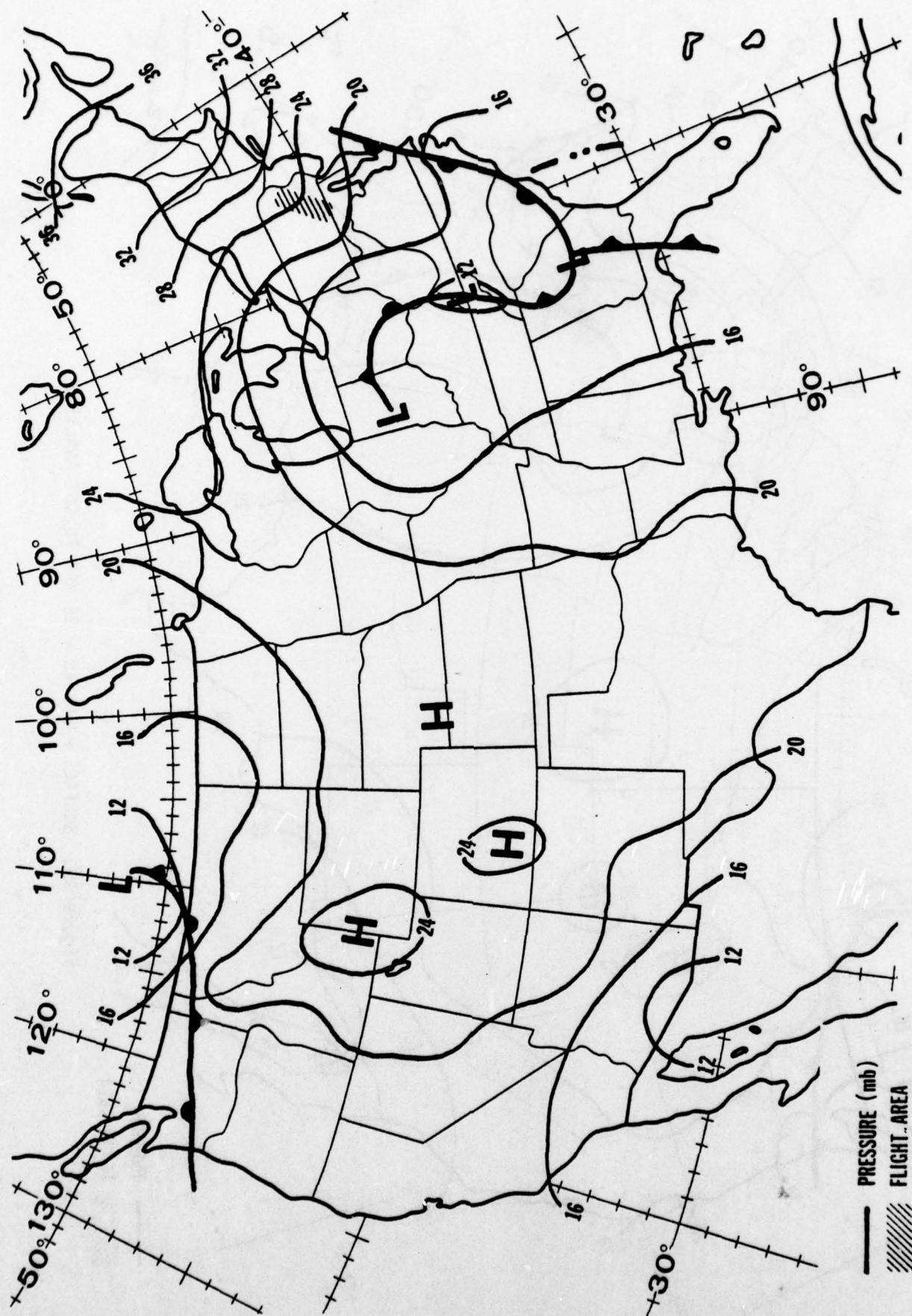


Figure 100. SURFACE PRESSURE - 26 MAR 78 12Z ANALYSIS

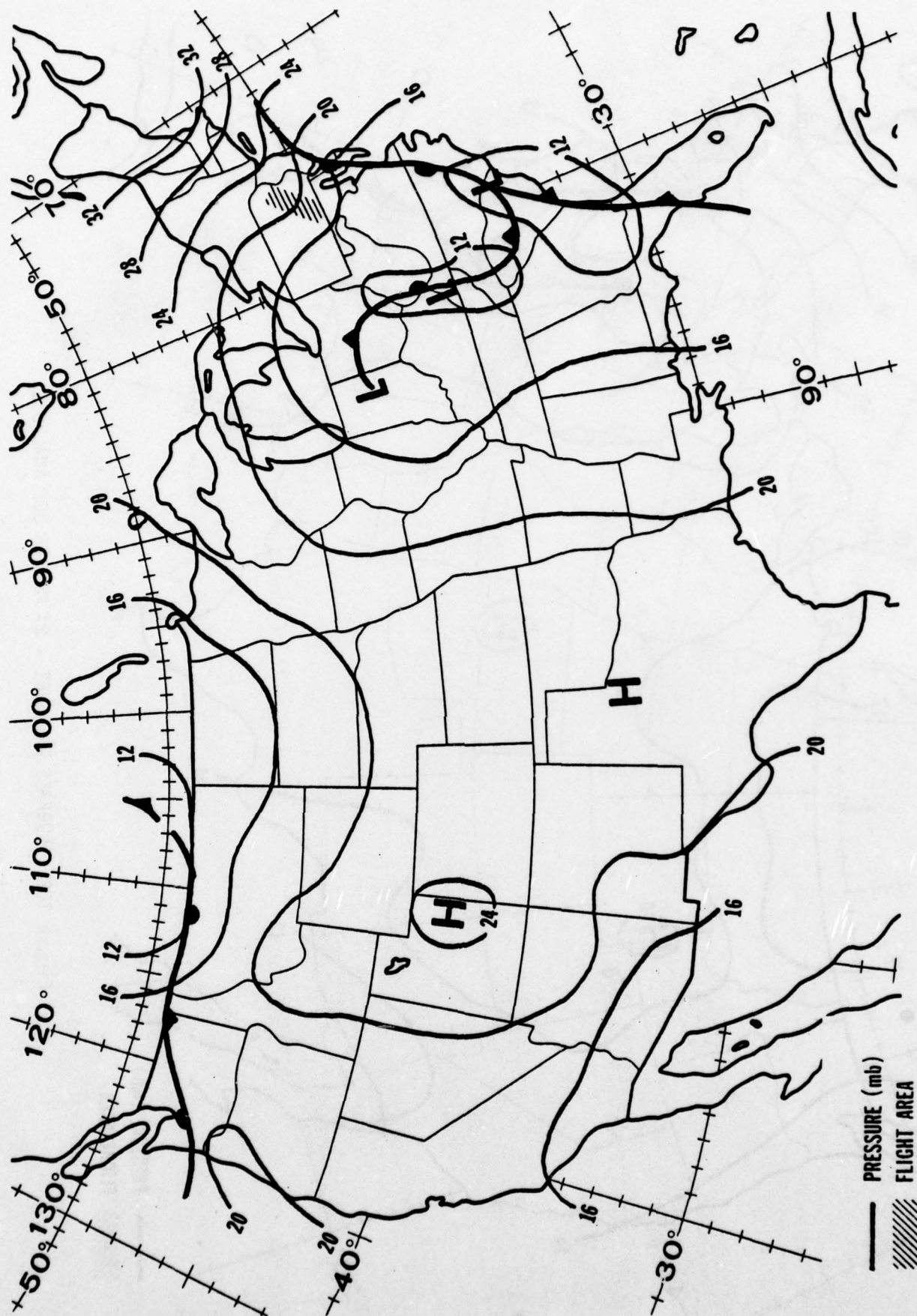


Figure 101. SURFACE PRESSURE - 26 MAR 78 18Z ANALYSIS

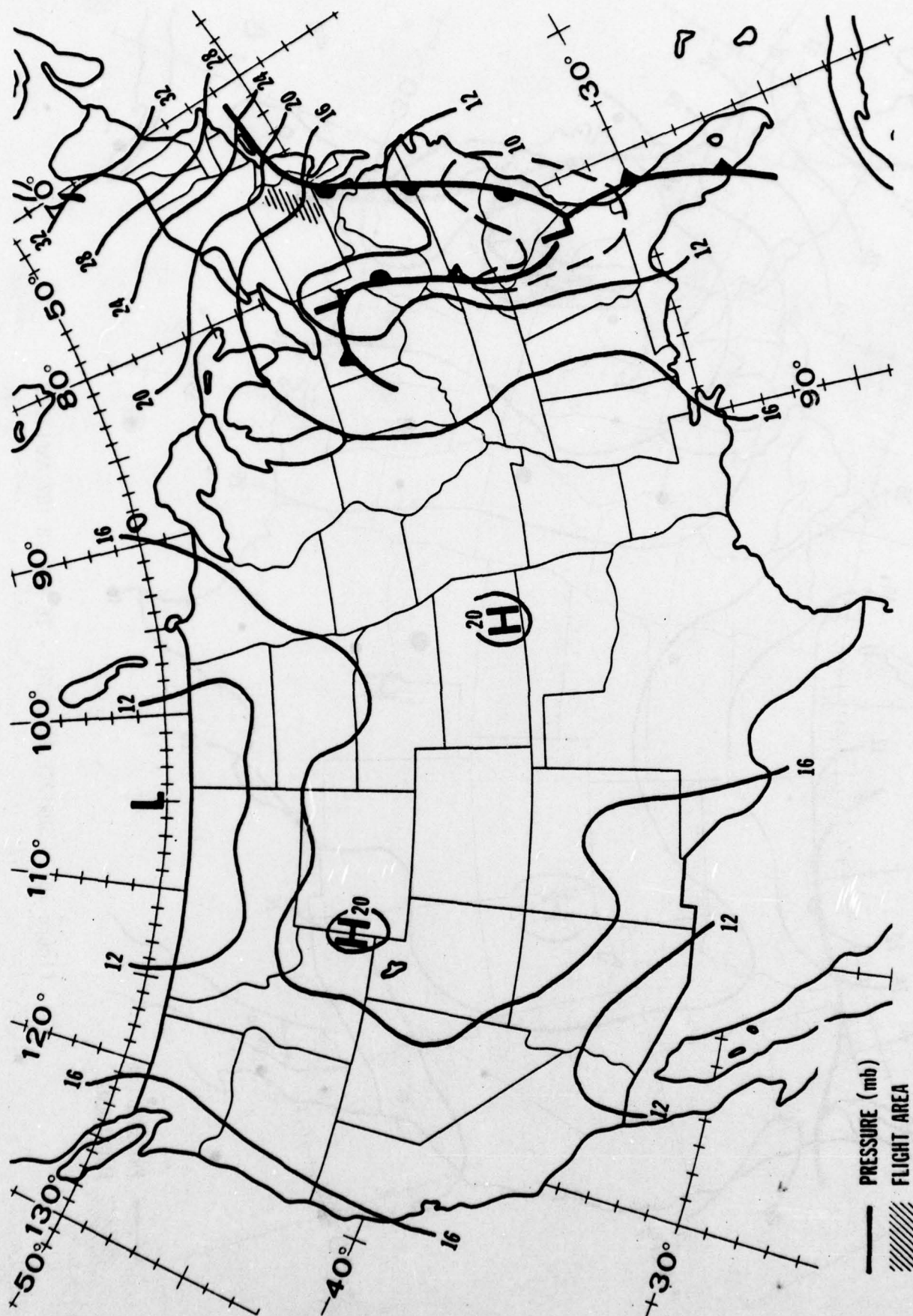


Figure 102. SURFACE PRESSURE - 27 MAR 78 00Z ANALYSIS

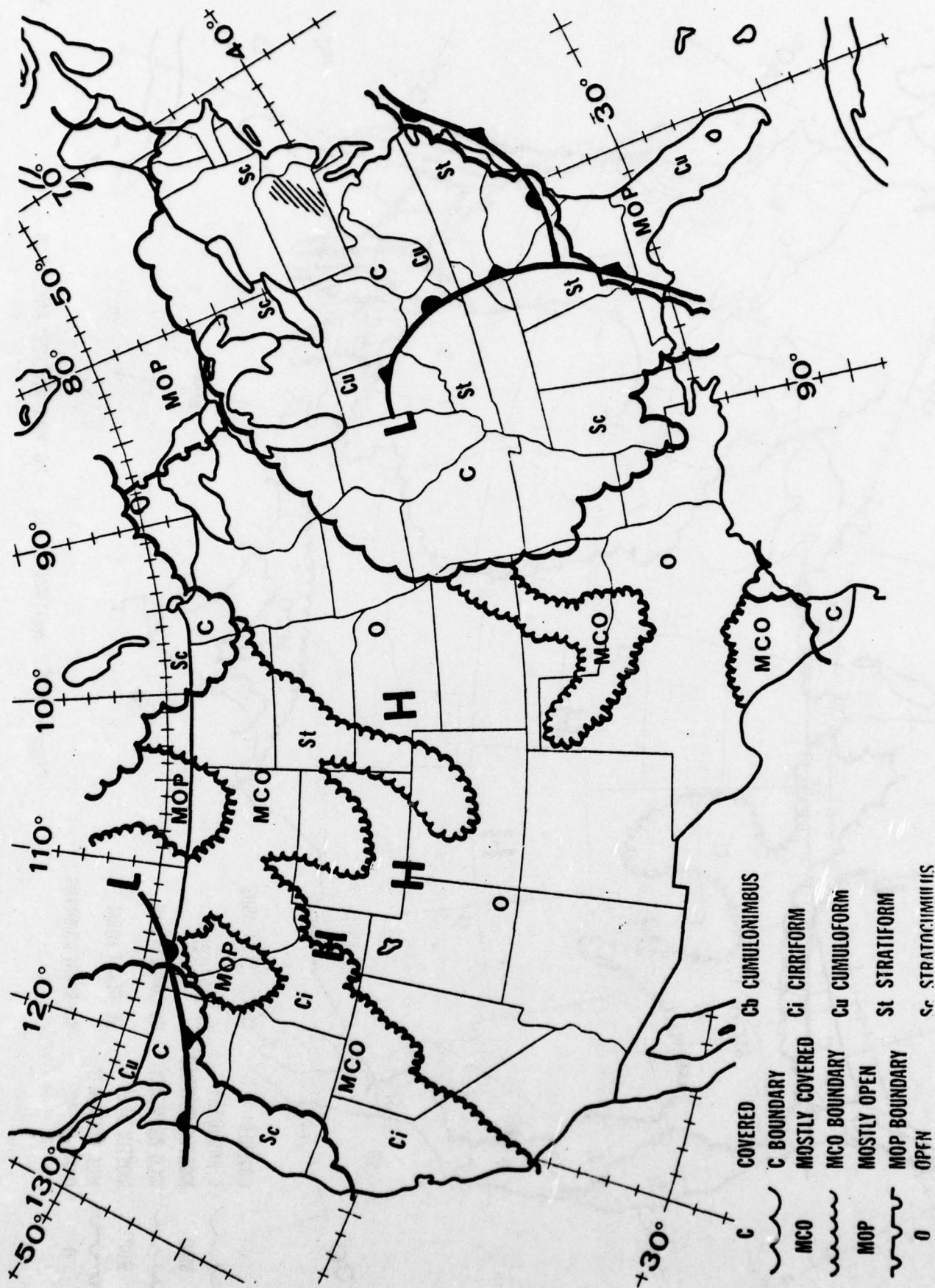


Figure 103. NEPHANALYSIS - 26 MAR 78 06Z ANALYSIS

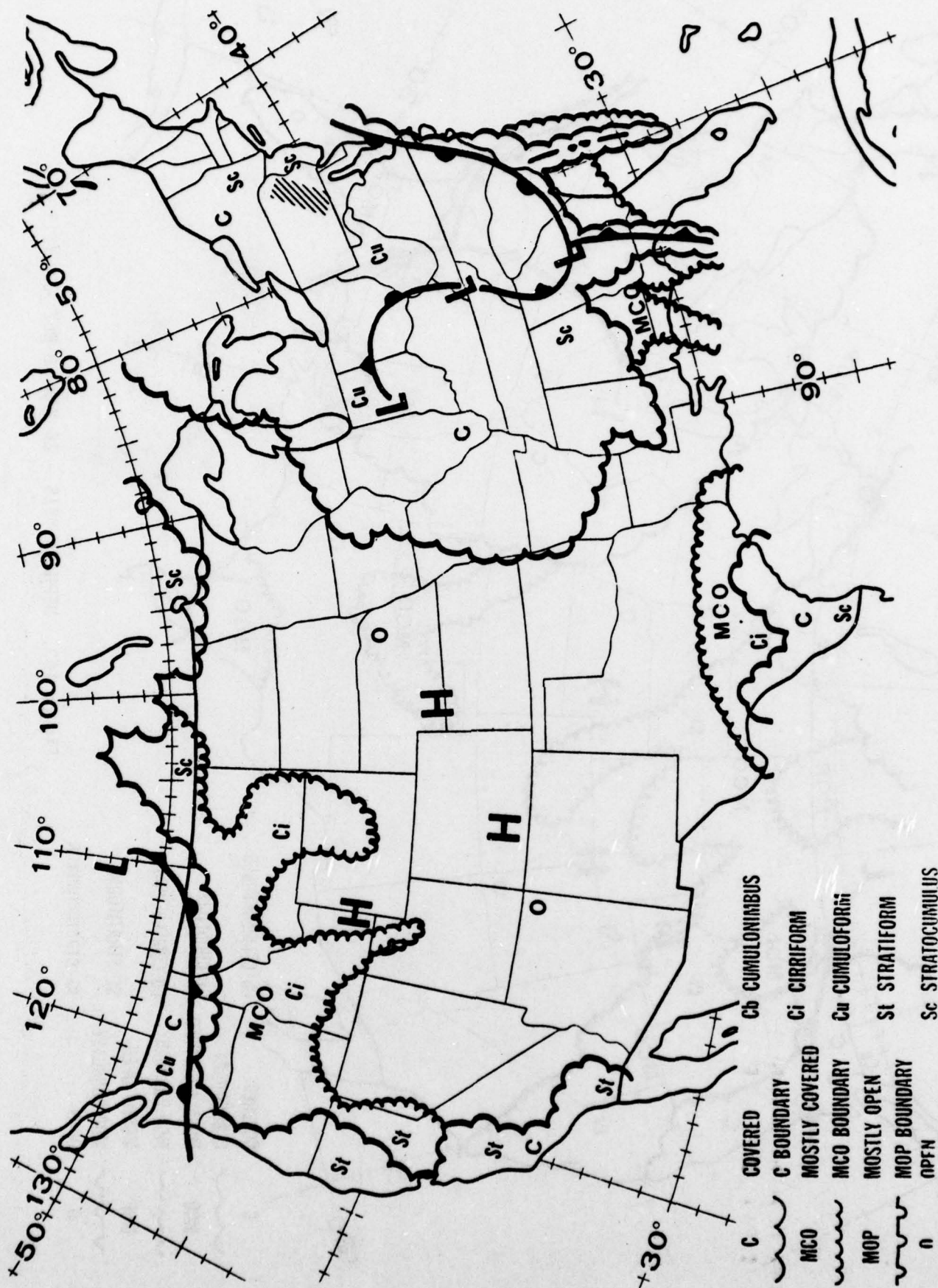


Figure 104. NEPHANALYSIS - 26 MAR 78 12Z ANALYSIS

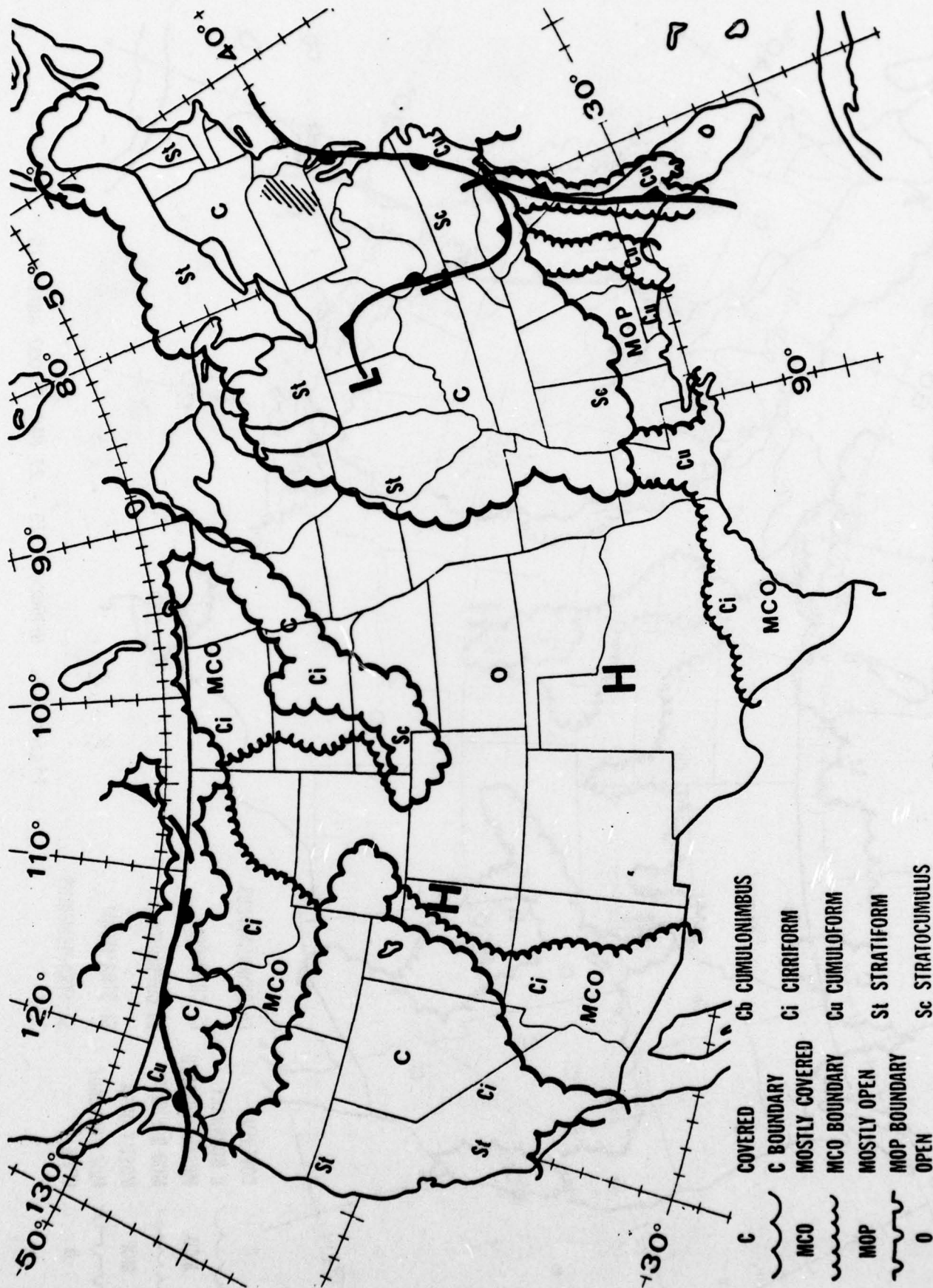


Figure 105. NEPHANALYSIS - 26 MAR 78 18Z ANALYSIS

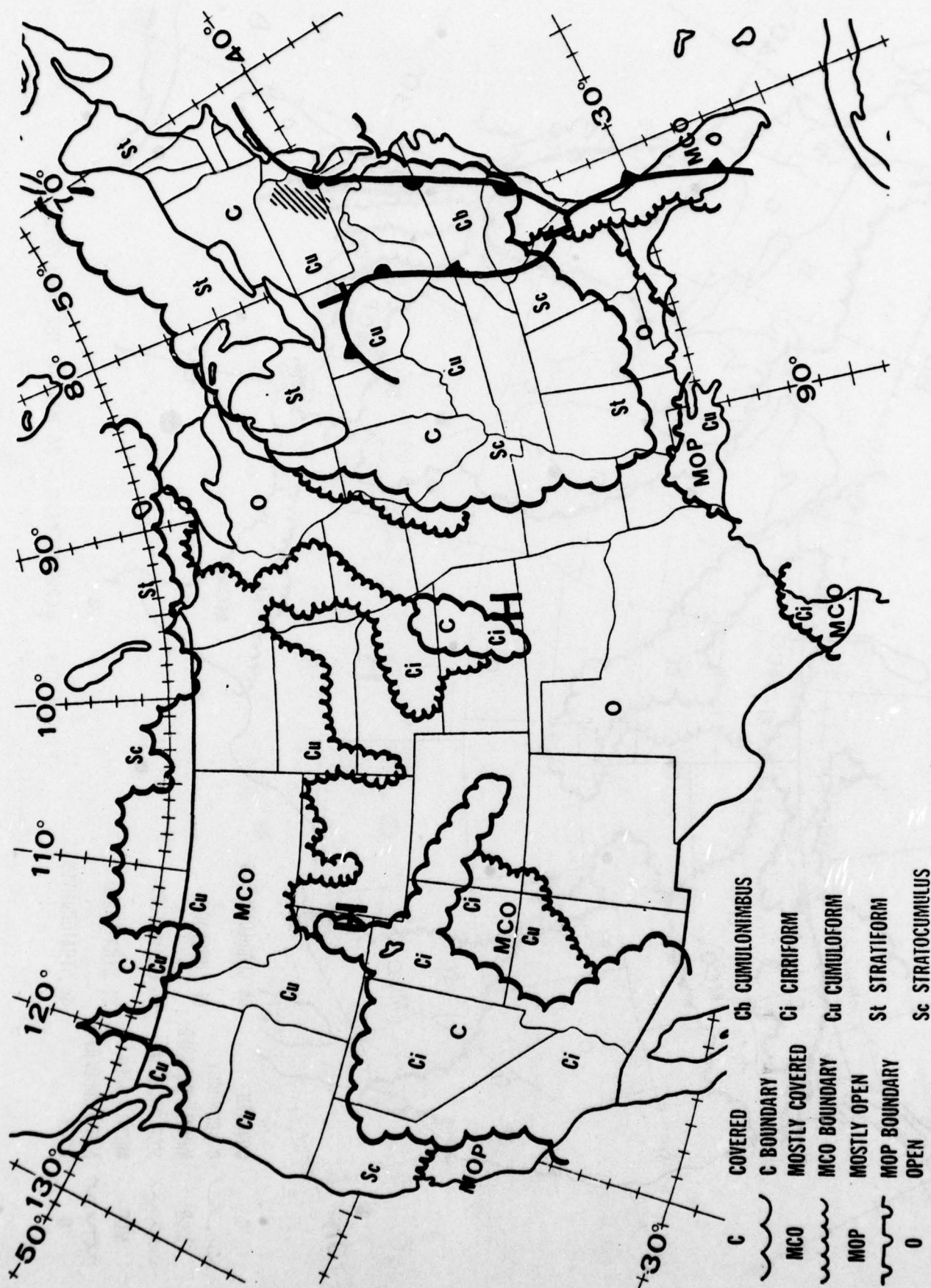


Figure 106. NEPHANALYSIS - 27 MAR 78 00Z ANALYSIS

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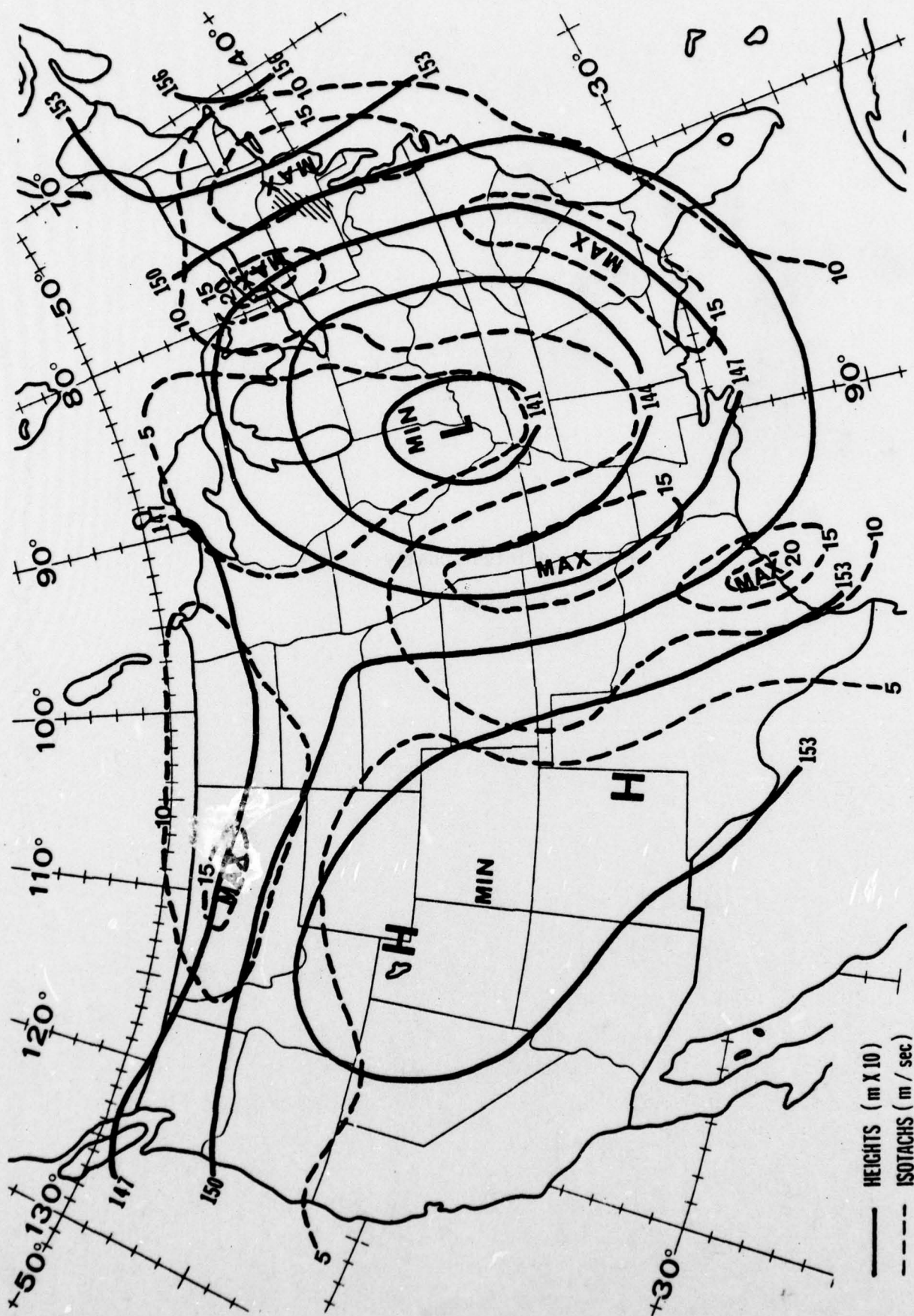


Figure 107. 850 mb HEIGHTS/ISOTACHS - 26 MAR 78 12Z ANALYSIS

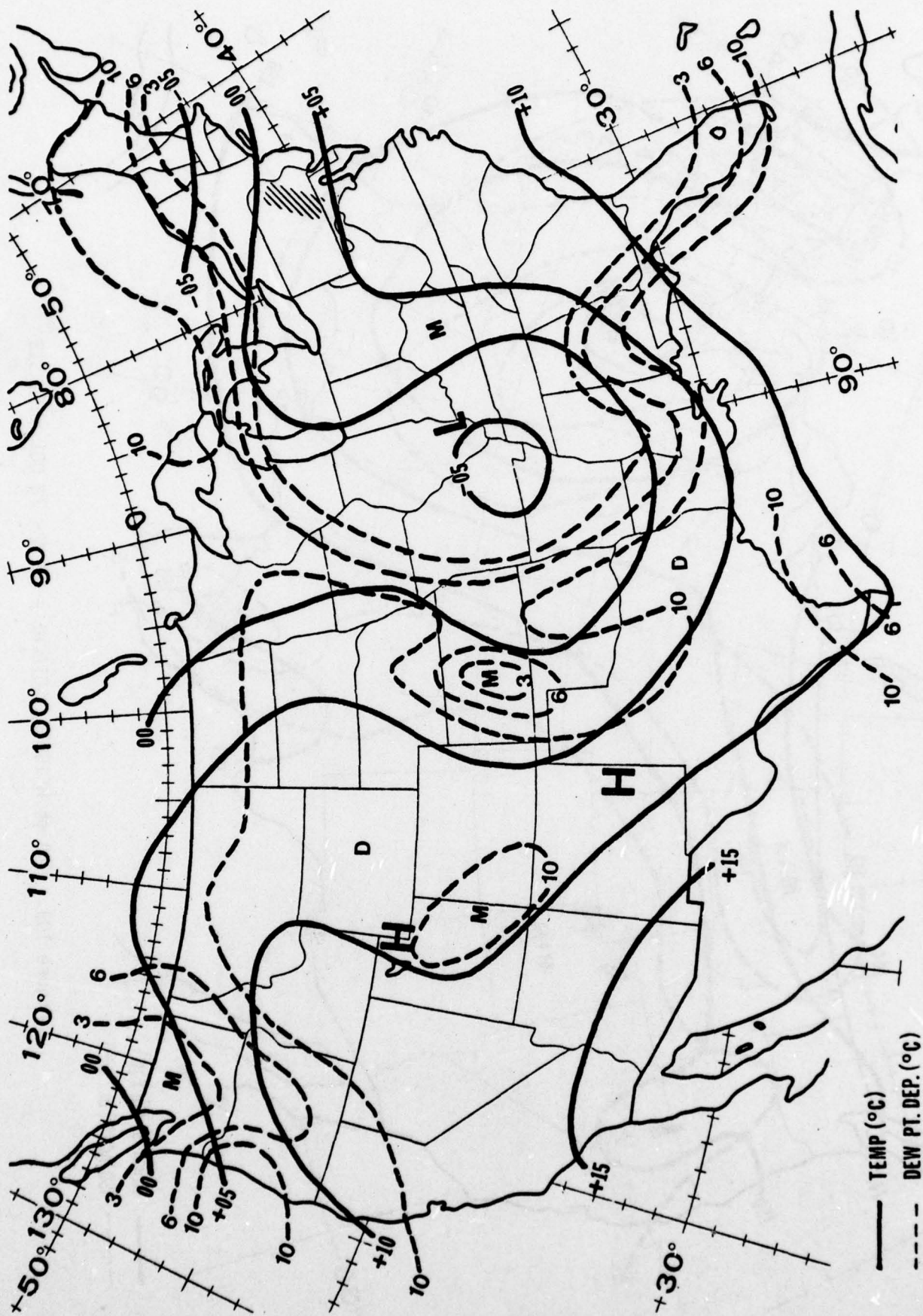


Figure 108. 850 mb TEMP./DEW PT. DEPRESSION - 26 MAR 78 12Z ANALYSIS

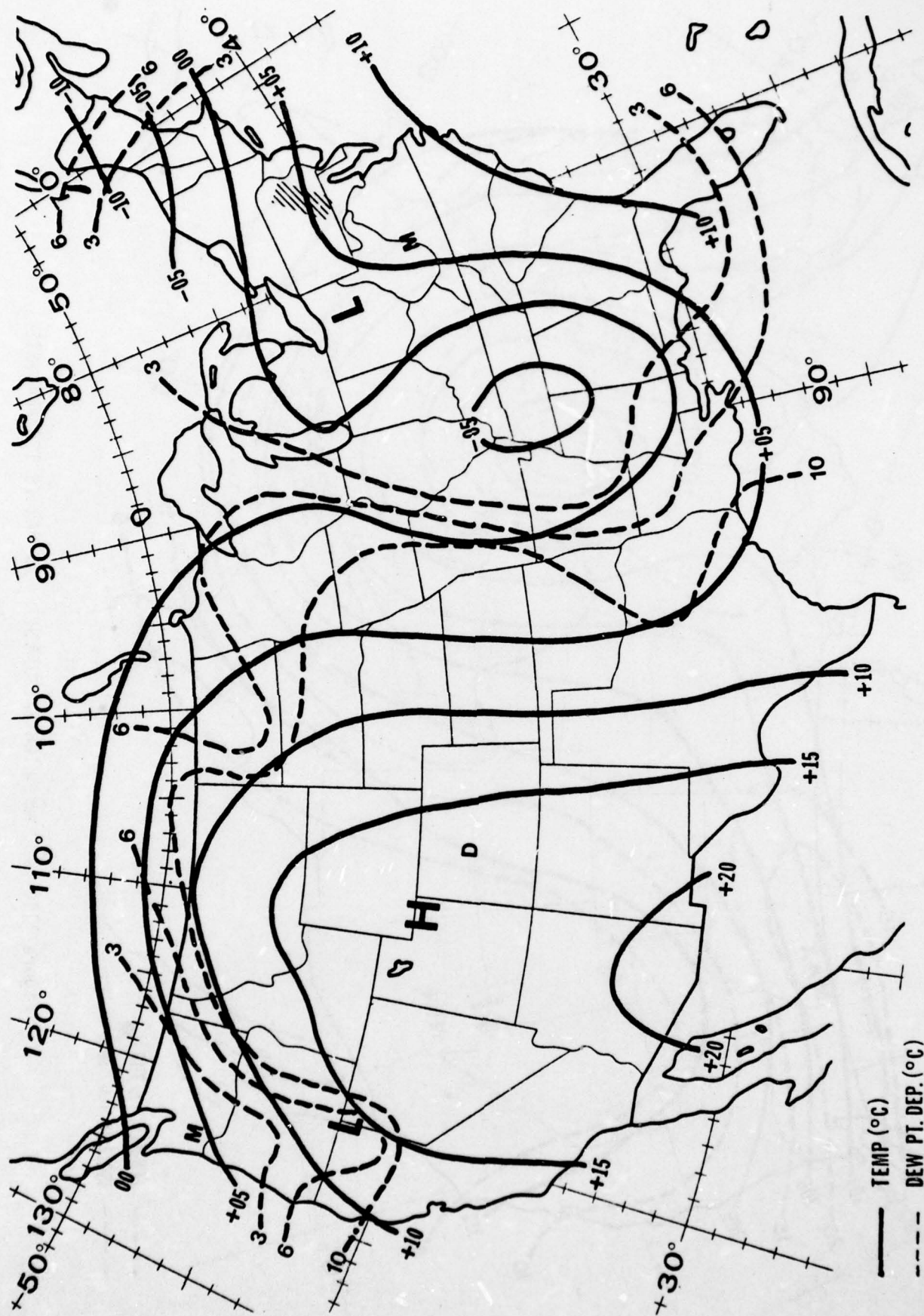


Figure 110. 850 mb TEMP./DEW PT. DEPRESSION - 27 MAR 78 00Z ANALYSIS

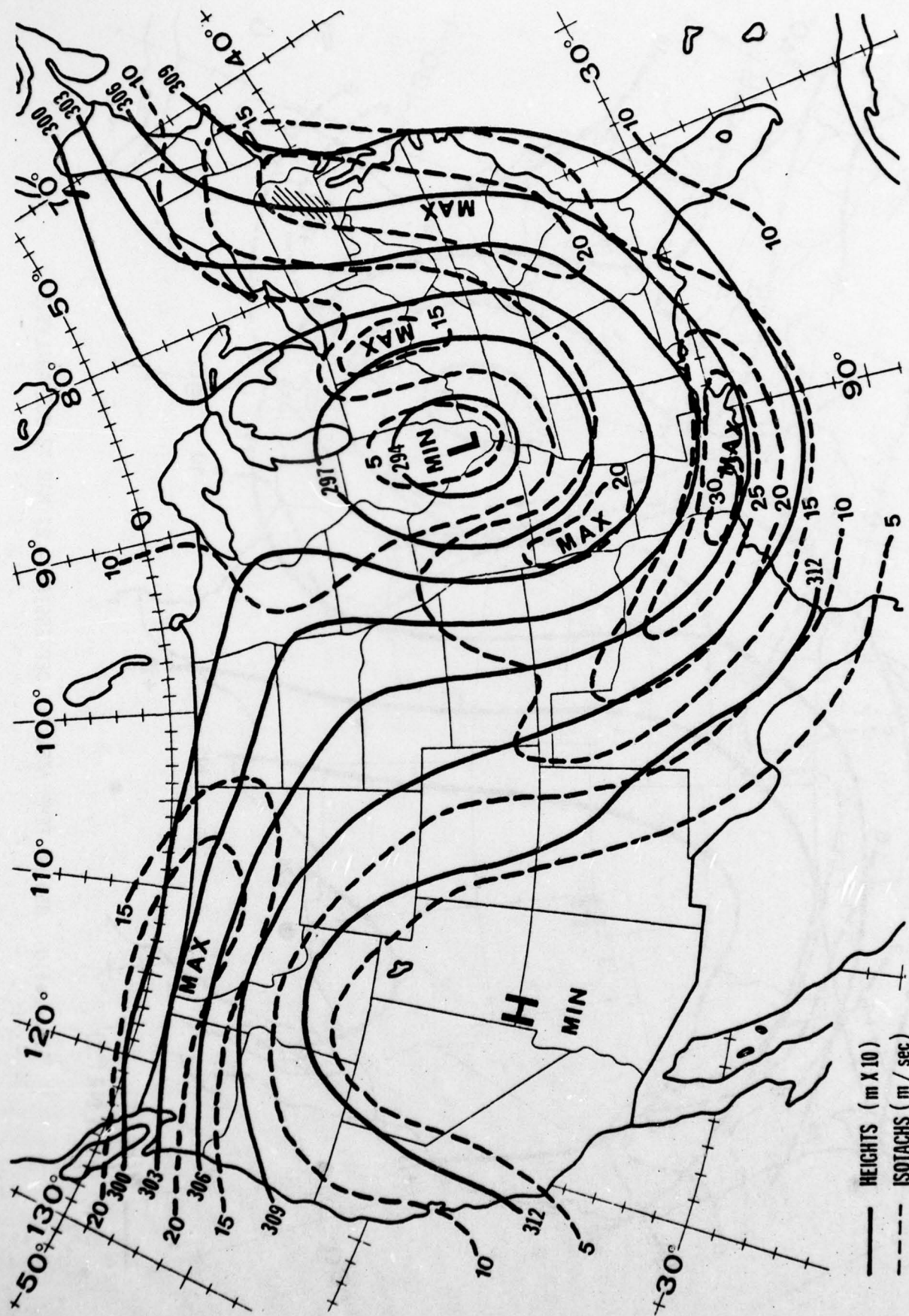


Figure 111. 700 mb HEIGHTS/ISOTACHS - 26 MAR 78 12Z ANALYSIS

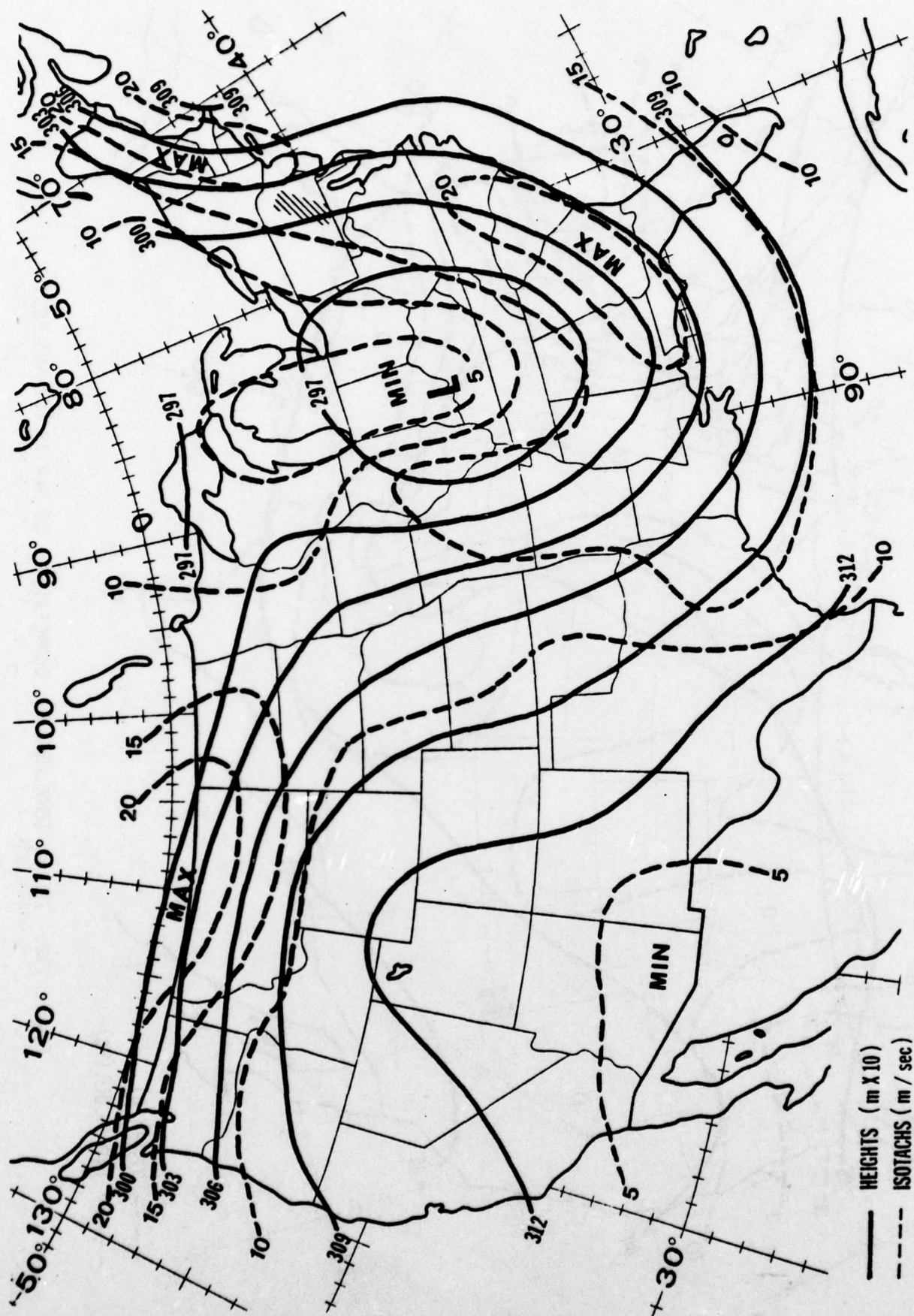


Figure 113. 700 mb HEIGHTS/ISOTACHS - 27 MAR 78 00Z ANALYSIS

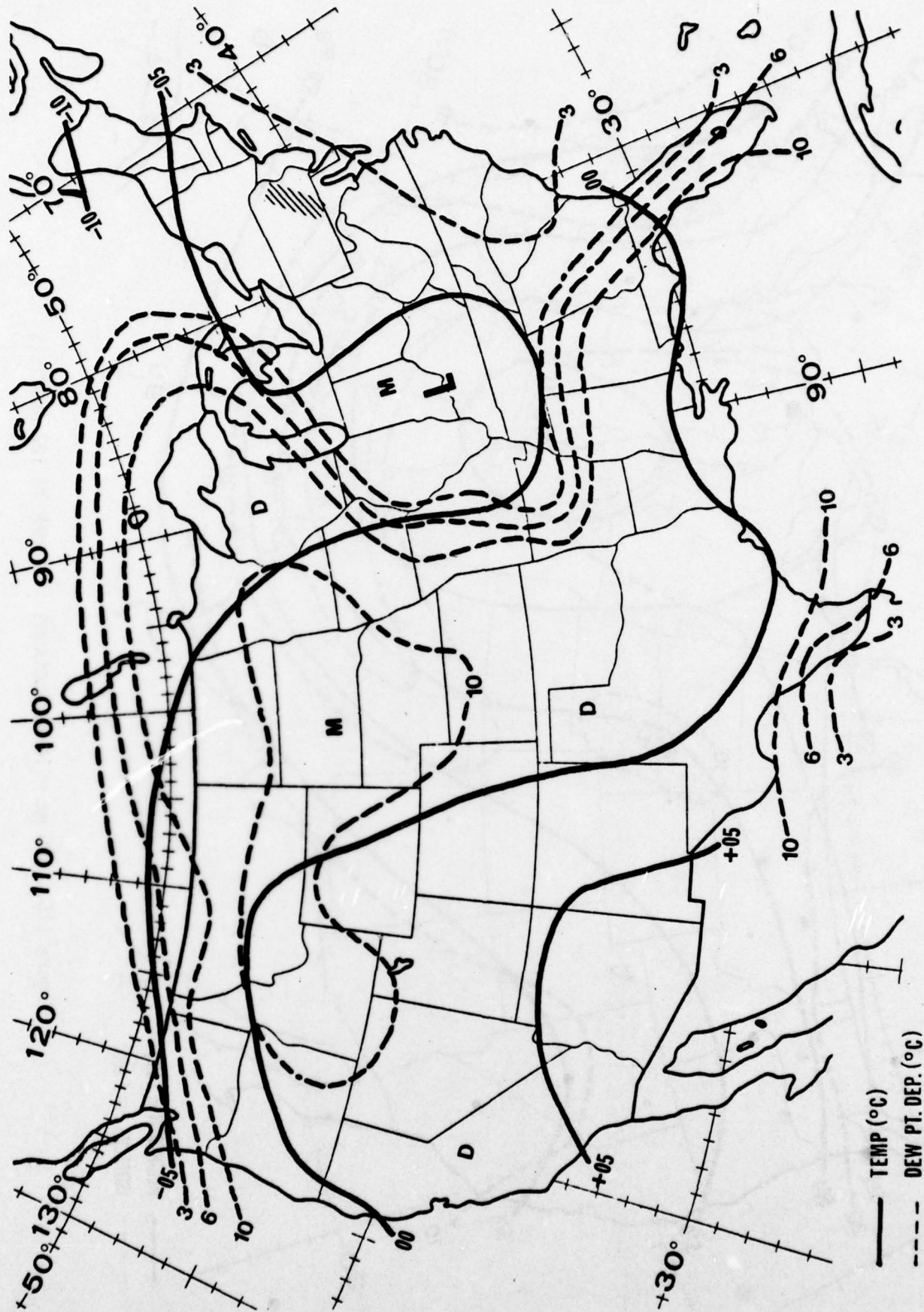


Figure 114. 700 mb TEMP./DEW PT. DEPRESSION - 27 MAR 78 00Z ANALYSIS

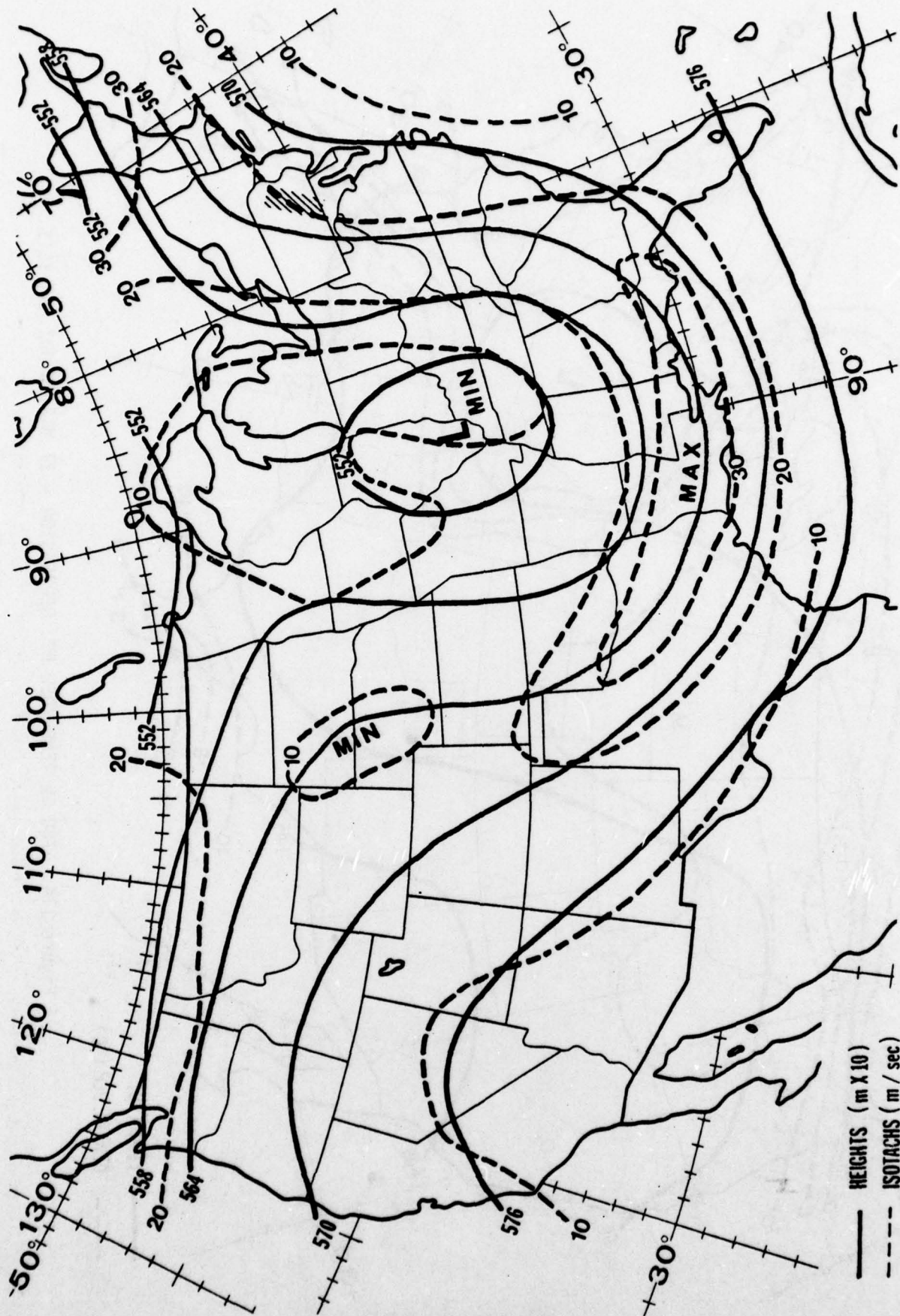


Figure 115. 500 mb HEIGHTS/ISOTACHS - 26 MAR 78 12Z ANALYSIS

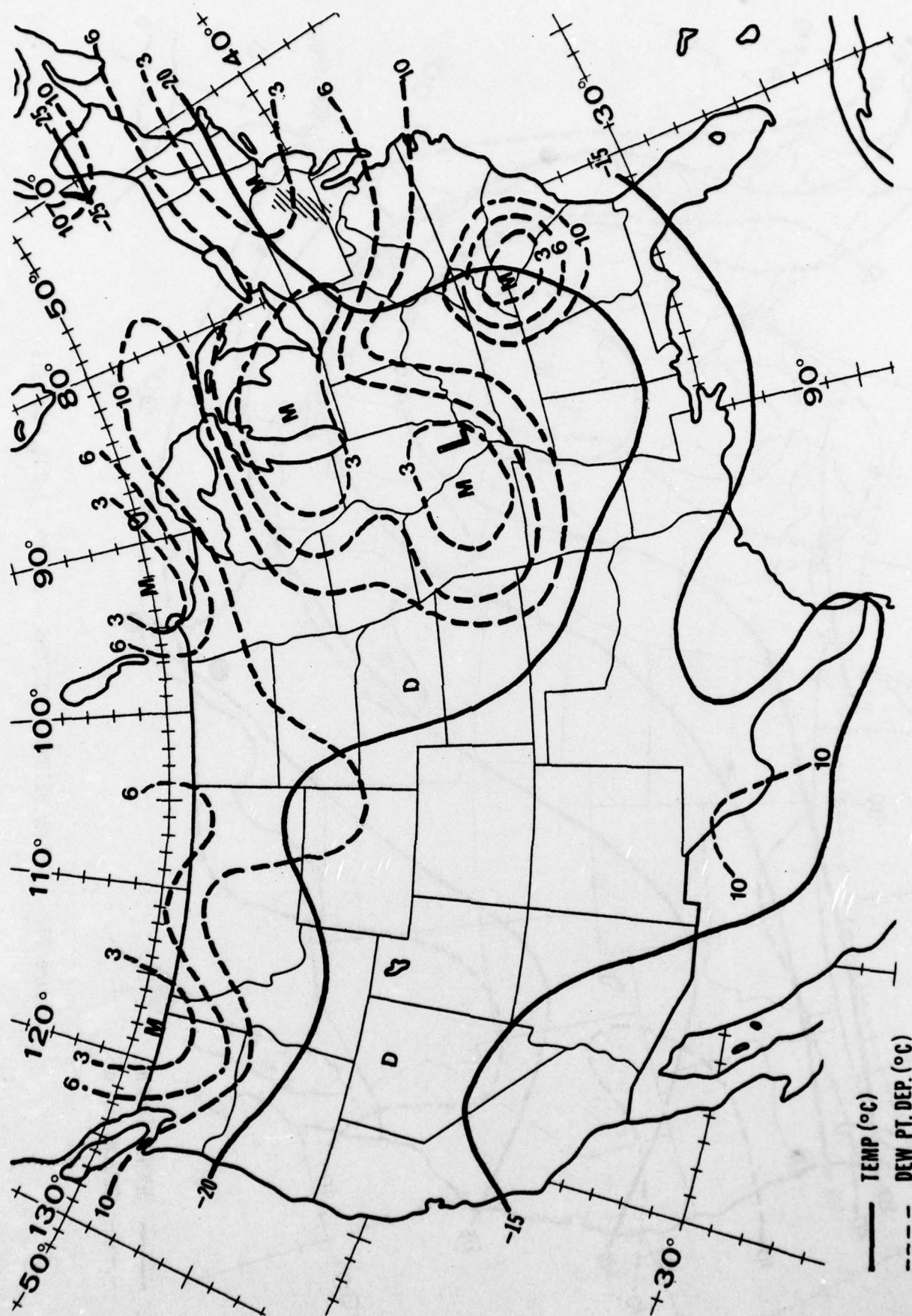


Figure 116. 500 mb TEMP./DEW PT. DEPRESSION - 26 MAR 78 12Z ANALYSIS

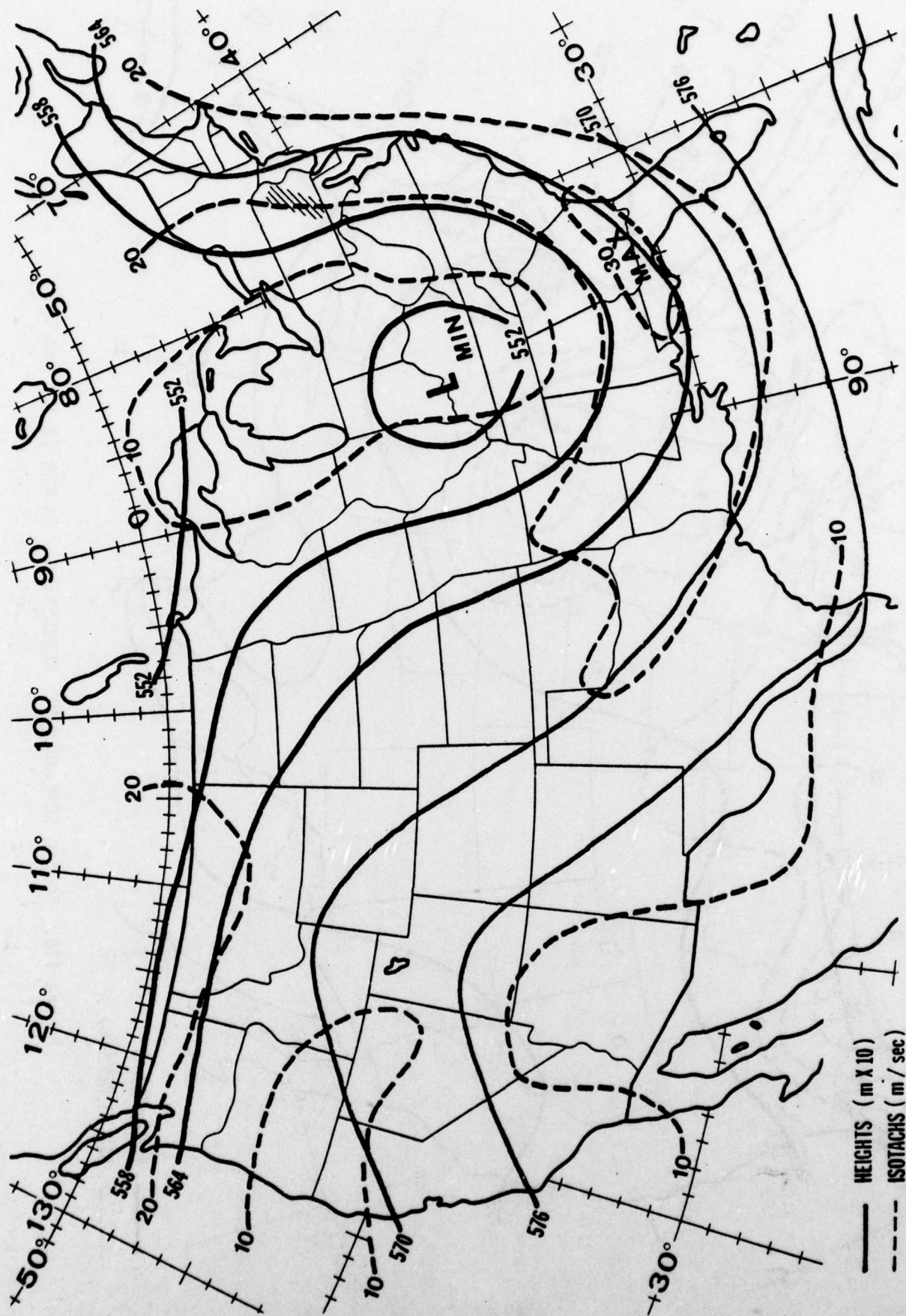


Figure 117. 500 mb HEIGHTS/ISOTACHS - 27 MAR 78 00Z ANALYSIS

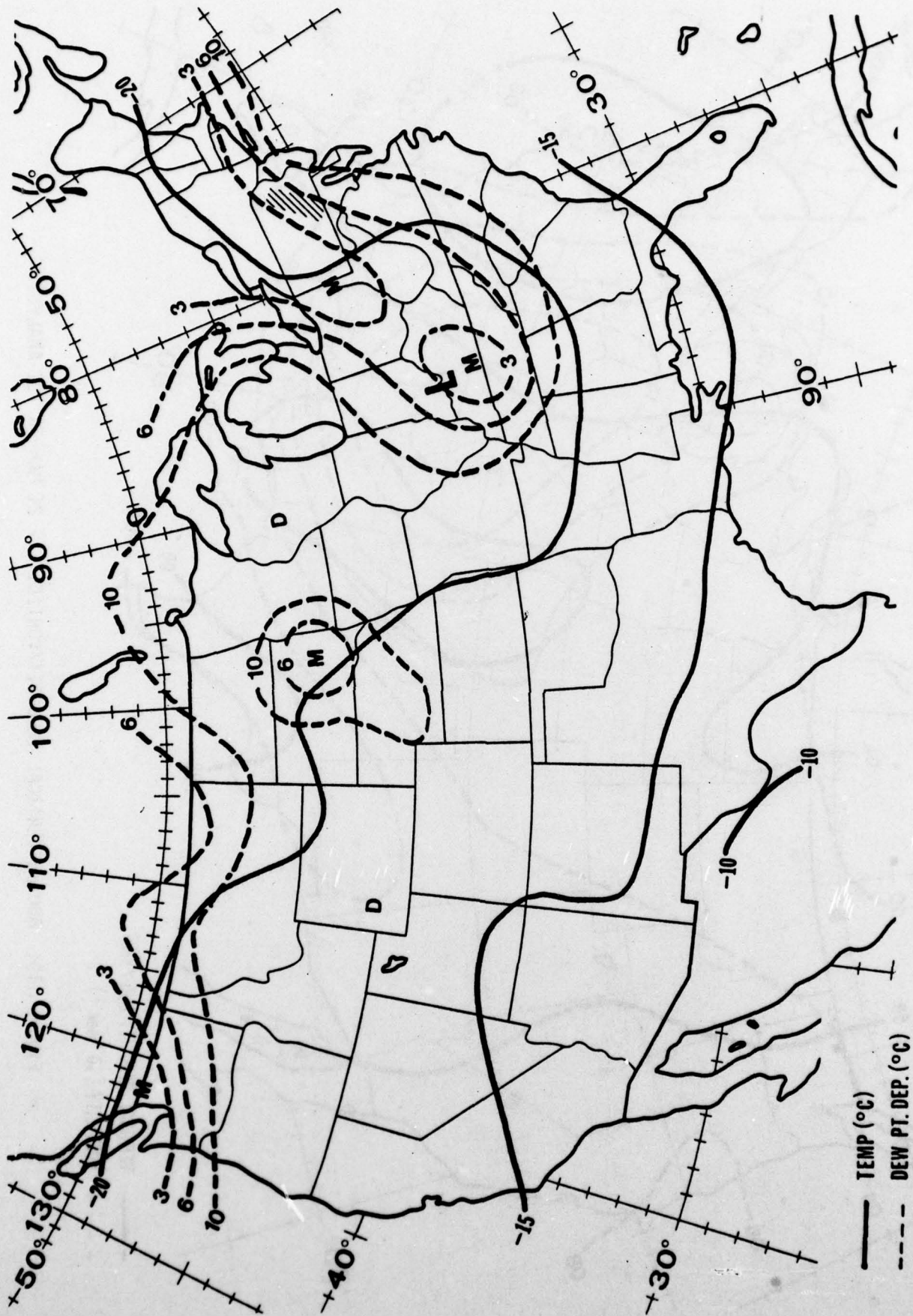


Figure 118. 500 mb TEMP./DEW PT. DEPRESSION - 27 MAR 78 00Z ANALYSIS

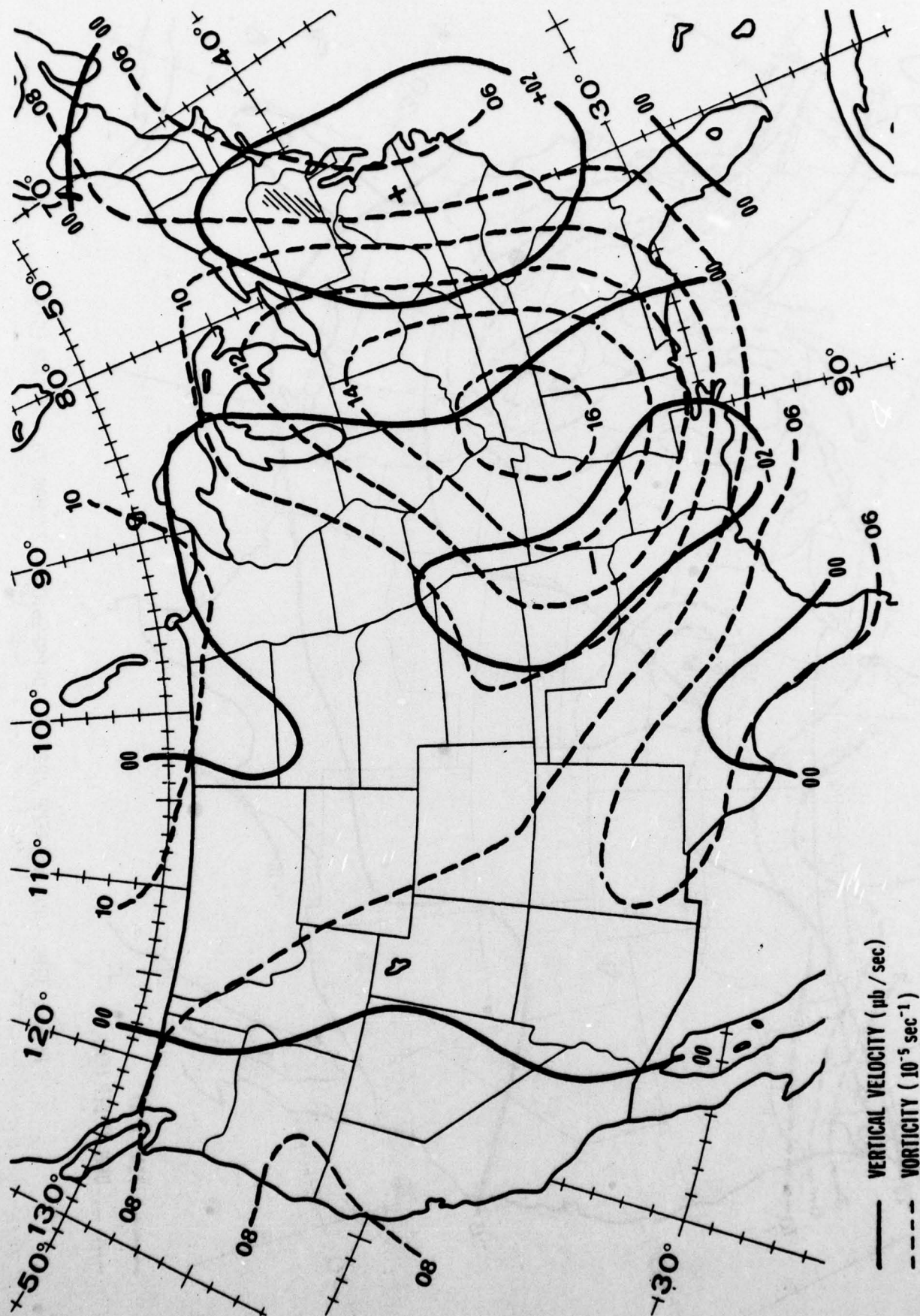


Figure 119. 500 mb VERTICAL VELOCITY/VORTICITY - 26 MAR 78 12Z ANALYSIS

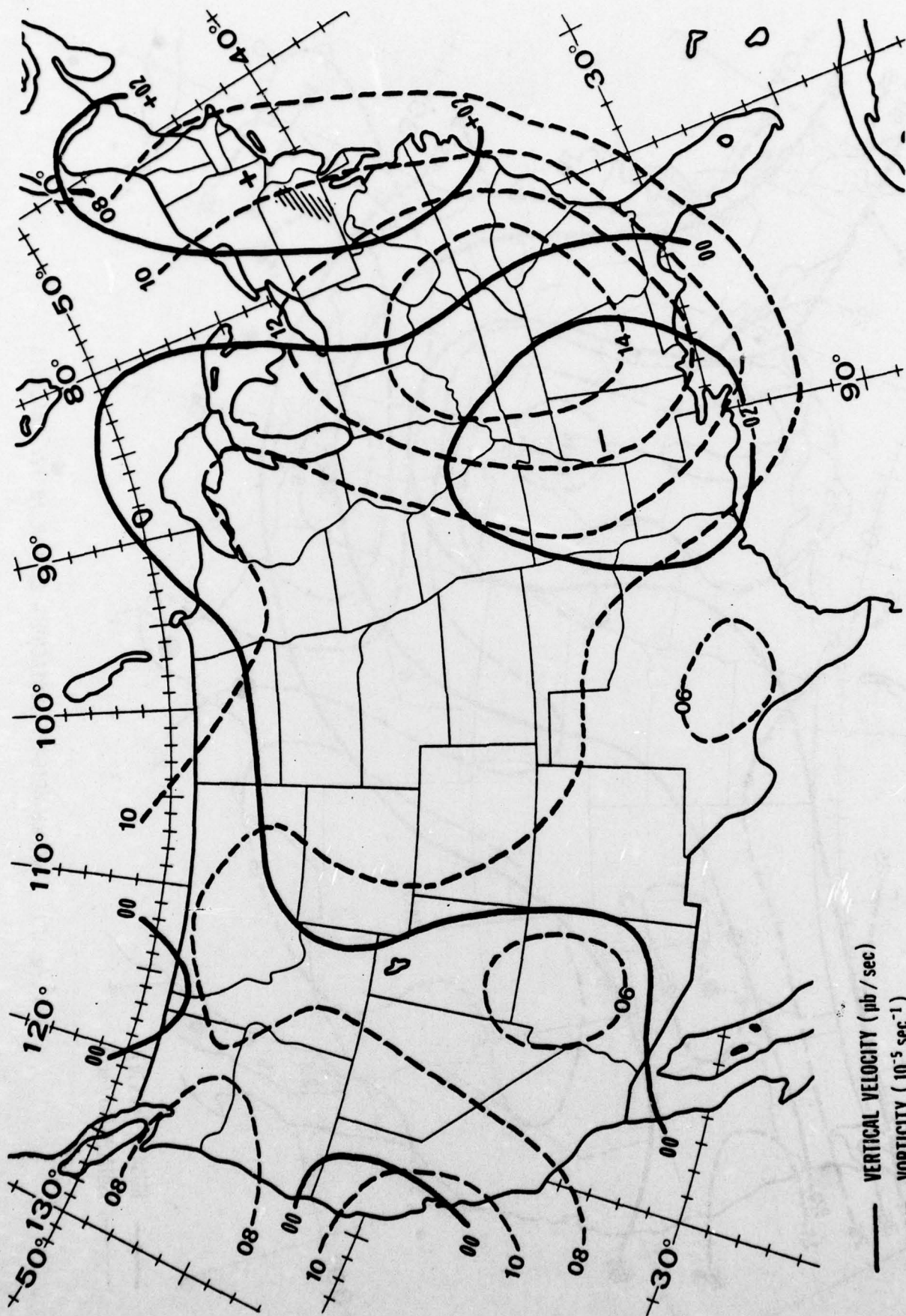


Figure 120. 500 mb VERTICAL VELOCITY/VORTICITY - 27 MAR 78 00Z ANALYSIS

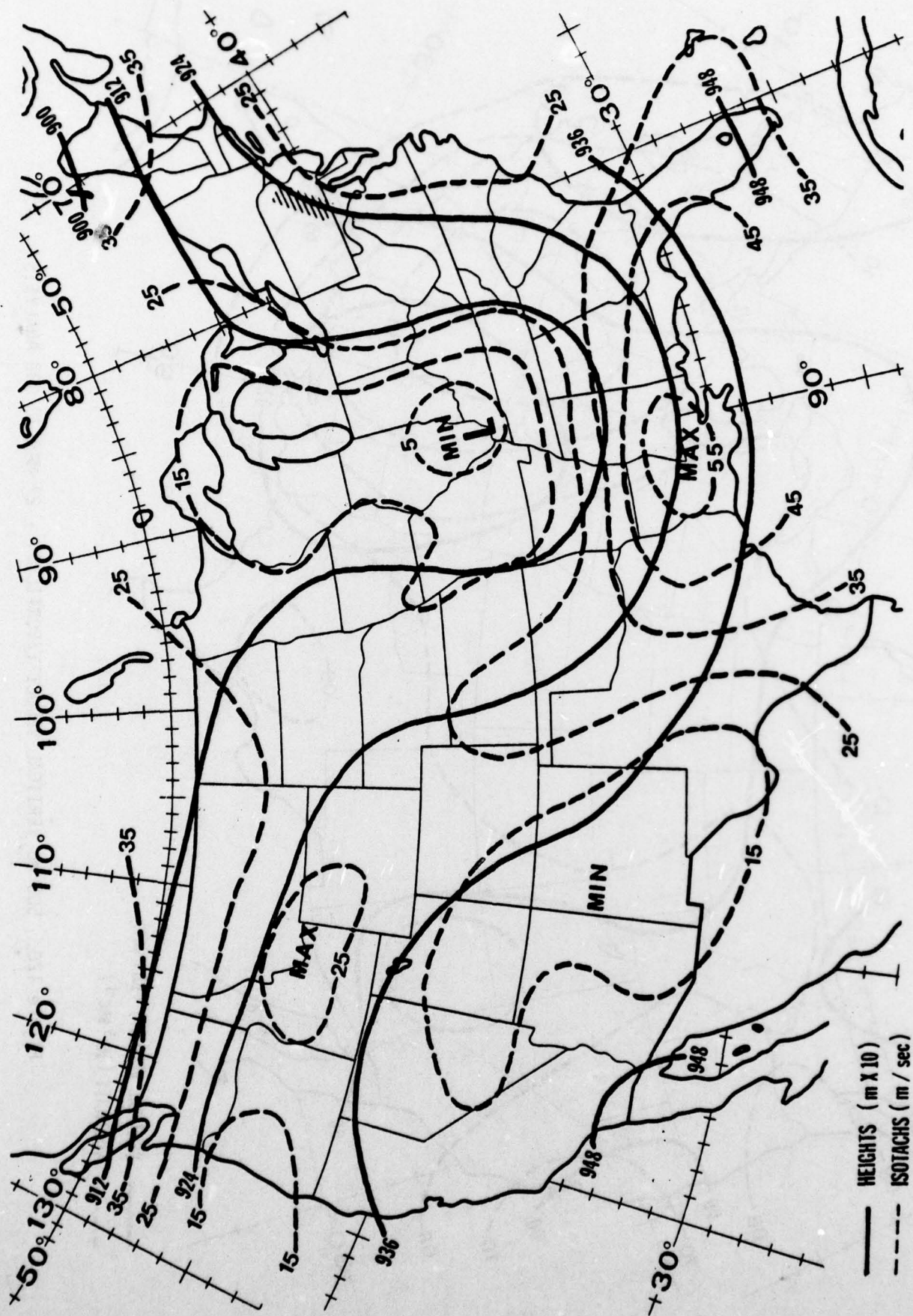


Figure 121. 300 mb HEIGHTS/ISOTACHS - 26 MAR 78 12Z ANALYSIS

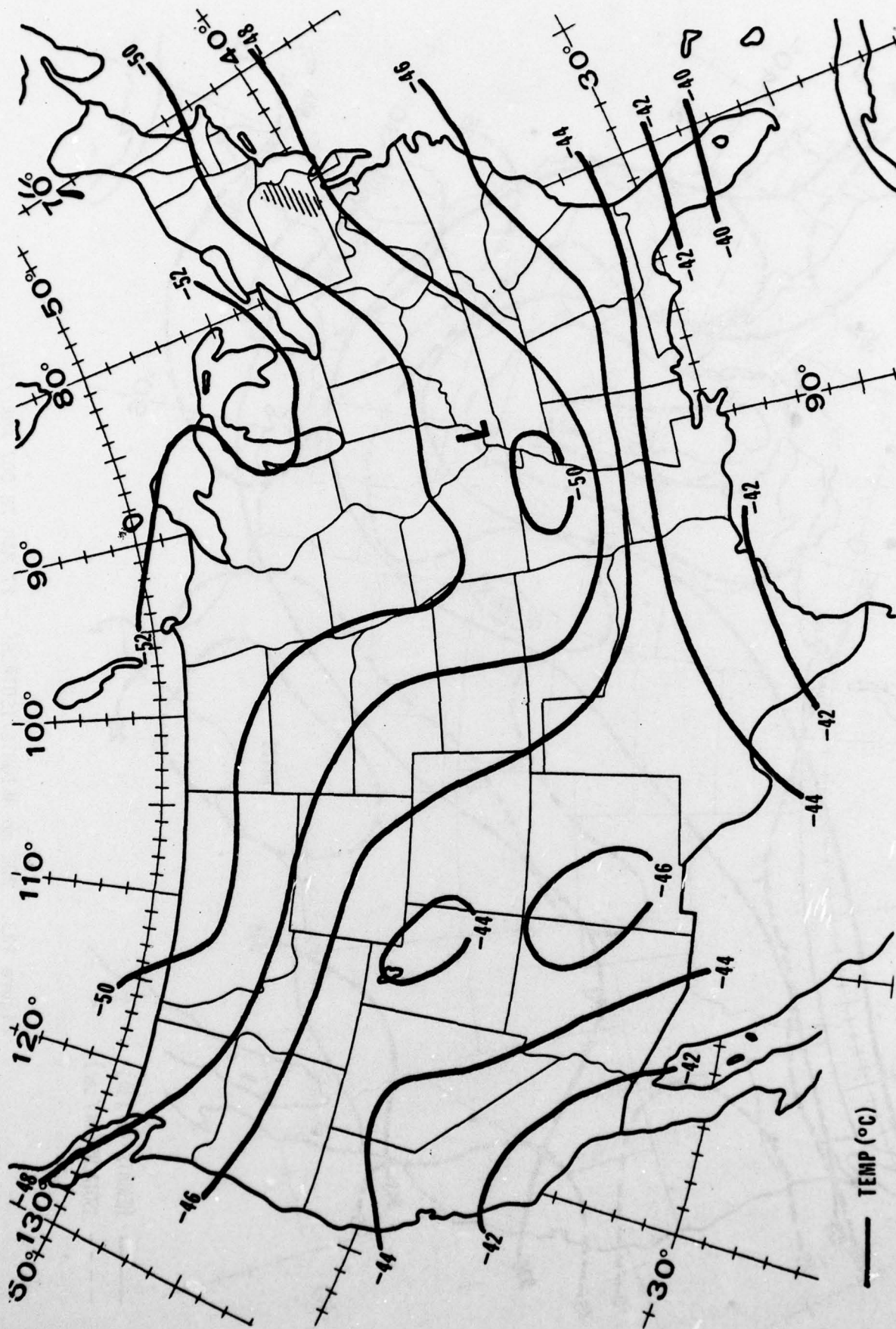


Figure 122. 300 mb TEMPERATURE - 26 MAR 78 12Z ANALYSIS

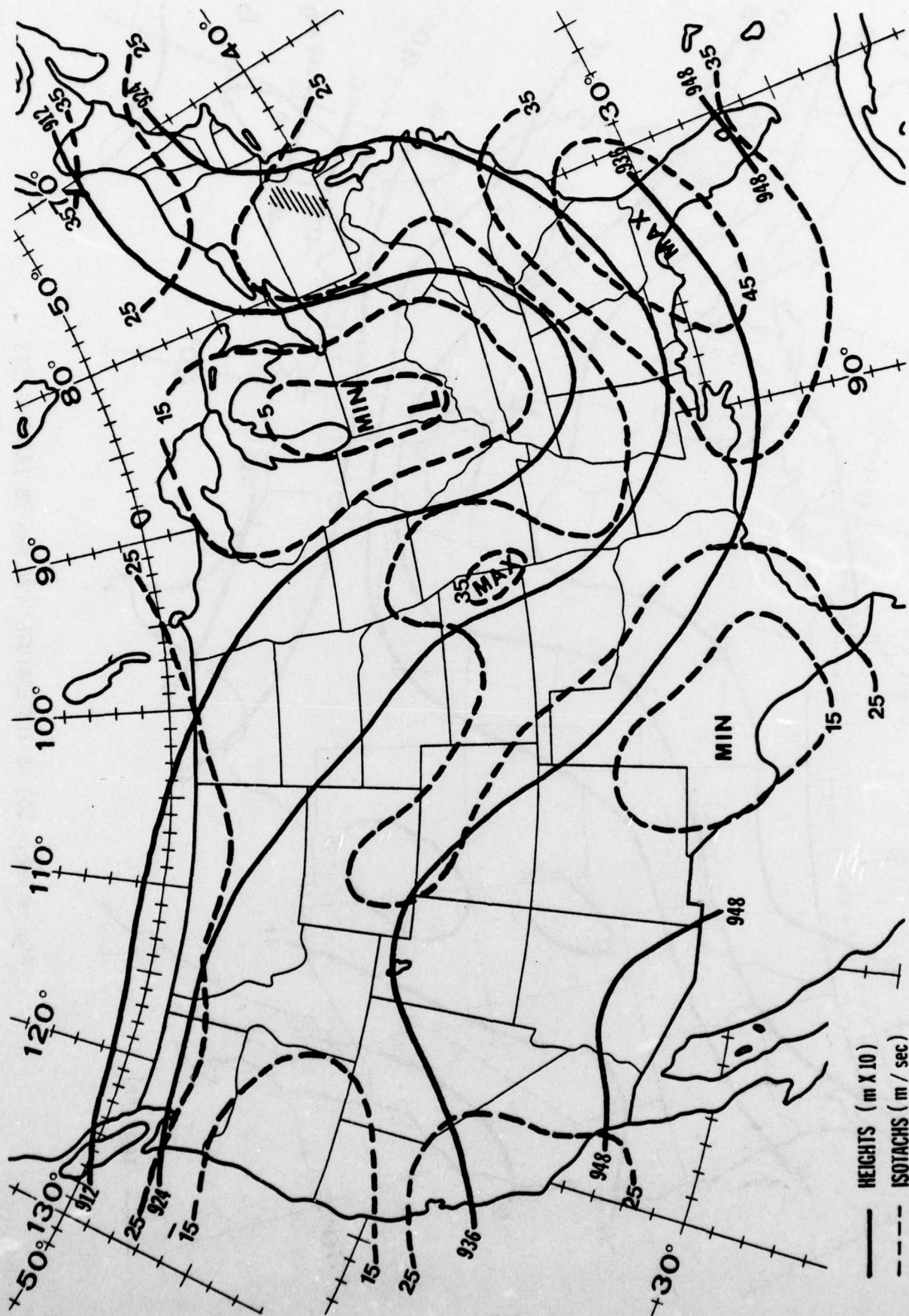


Figure 123. 300 mb HEIGHTS/ISOTACHS - 27 MAR 78 00Z ANALYSIS

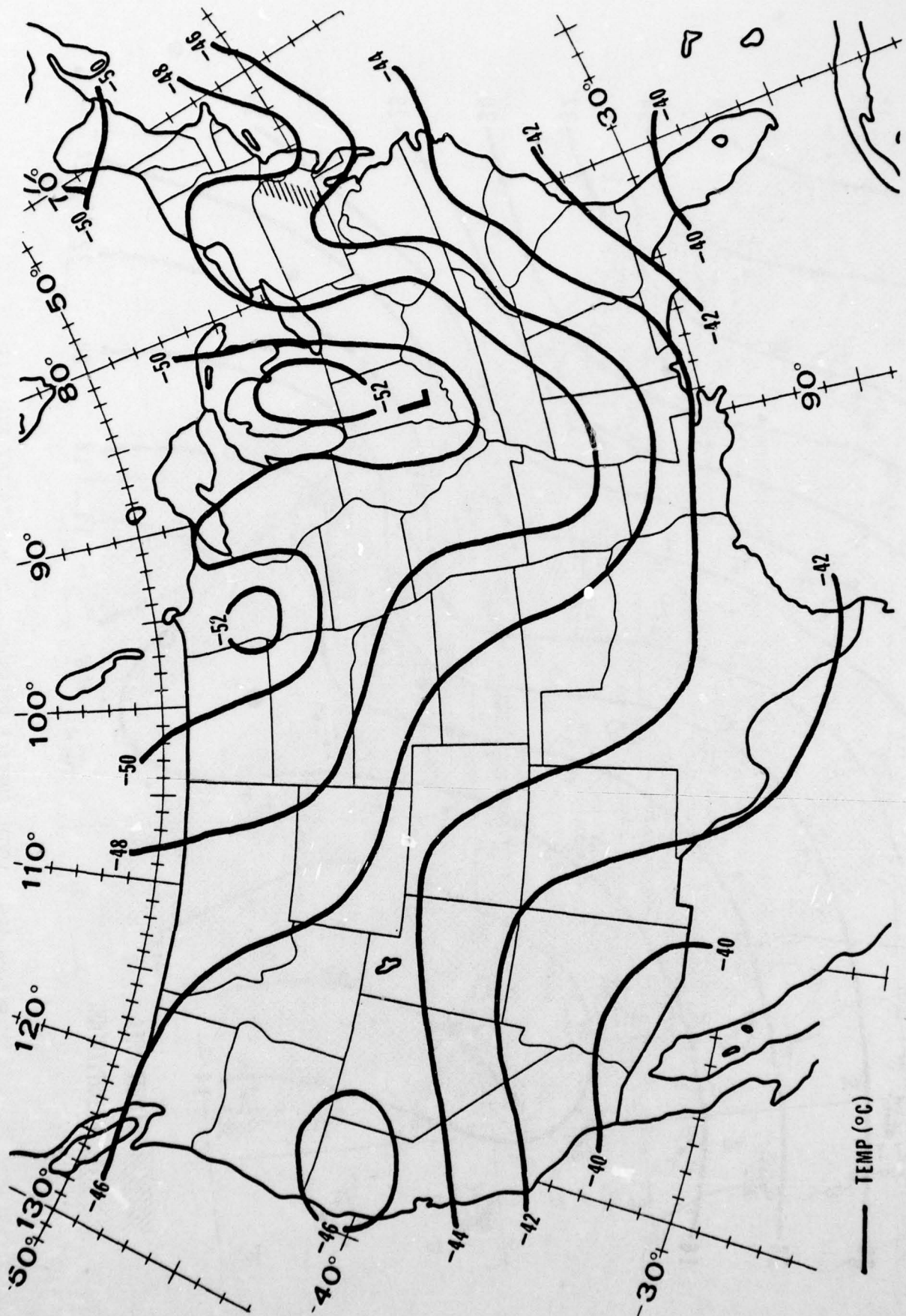


Figure 124. 300 mb TEMPERATURE - 27 MAR 78 00Z ANALYSIS

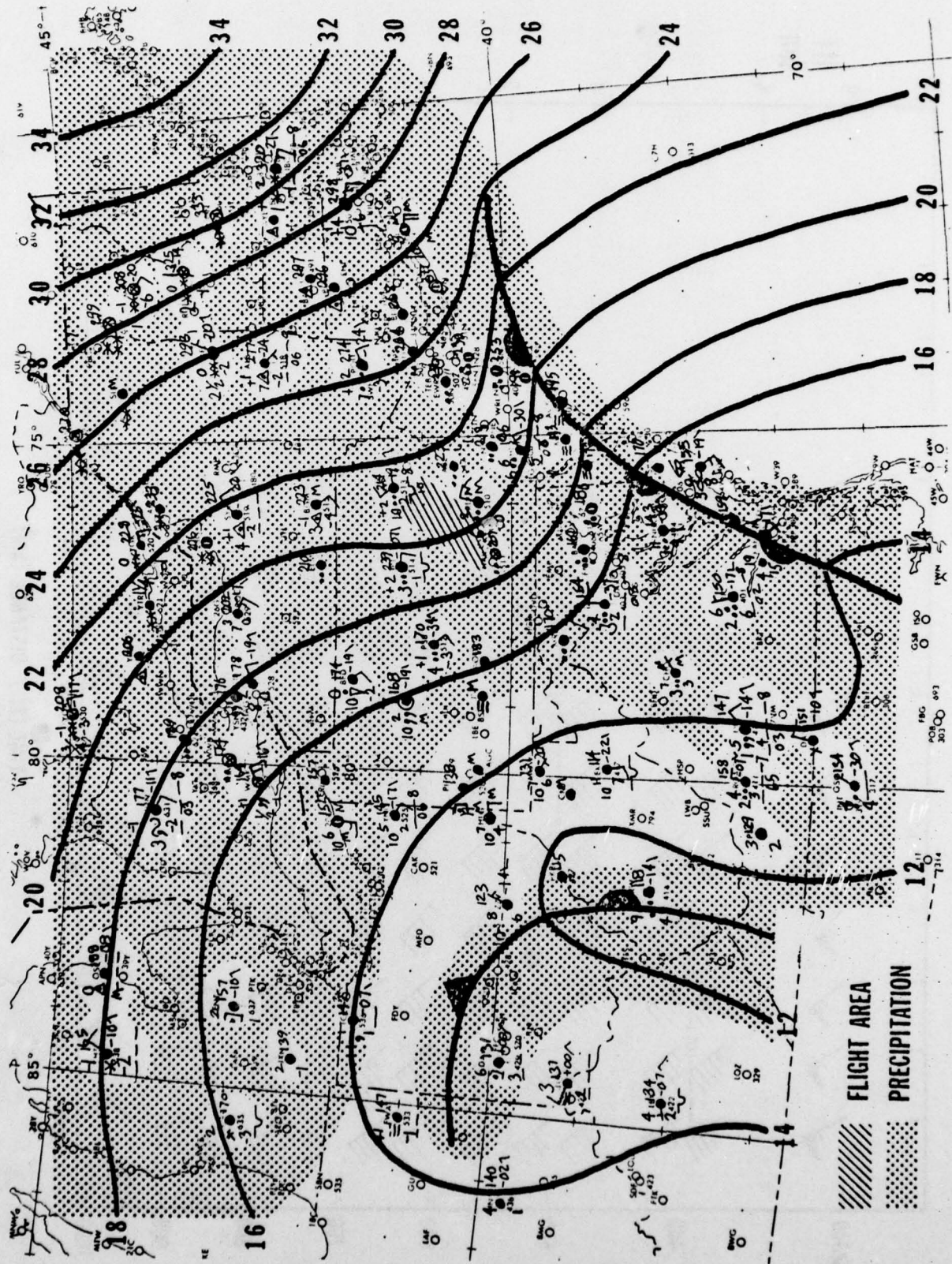


Figure 126. LOCAL SURFACE PRESSURE - 26 MAR 78 18Z ANALYSIS

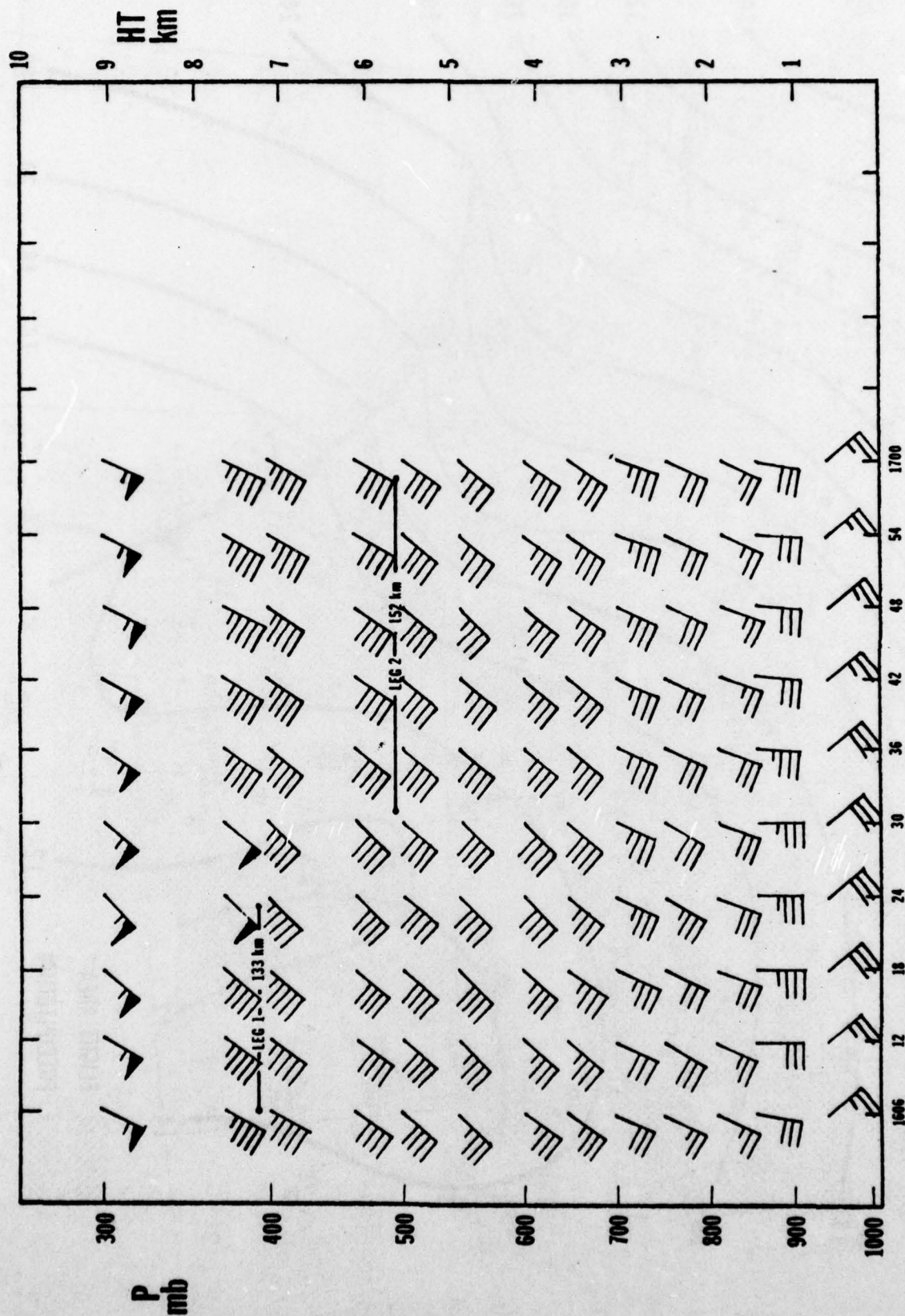


Figure 127. WIND CROSS-SECTION LEGS 1 AND 2 - 26 MAR 78 ANALYSIS

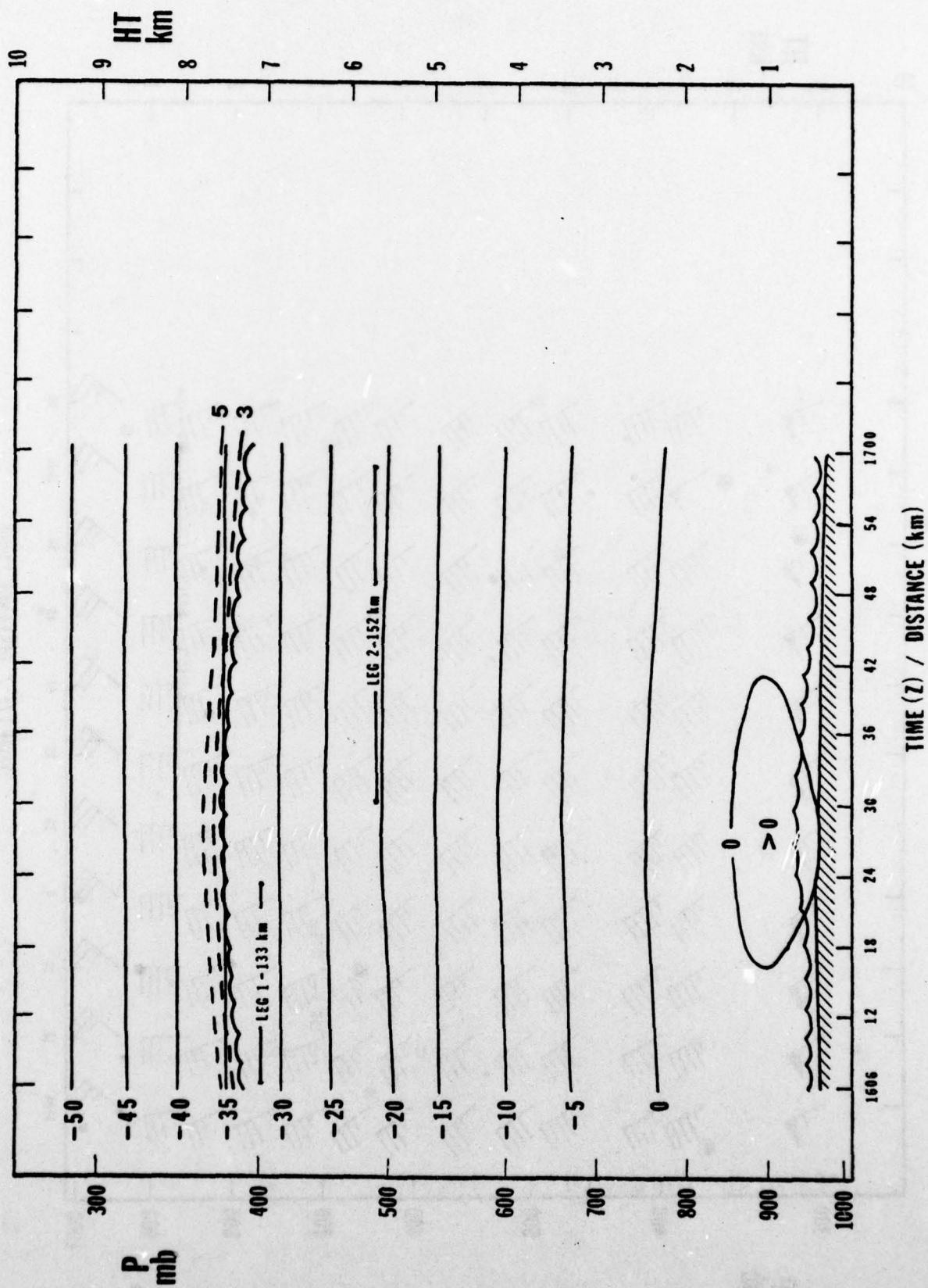


Figure 128. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 1 AND 2 - 26 MAR 78 ANALYSIS

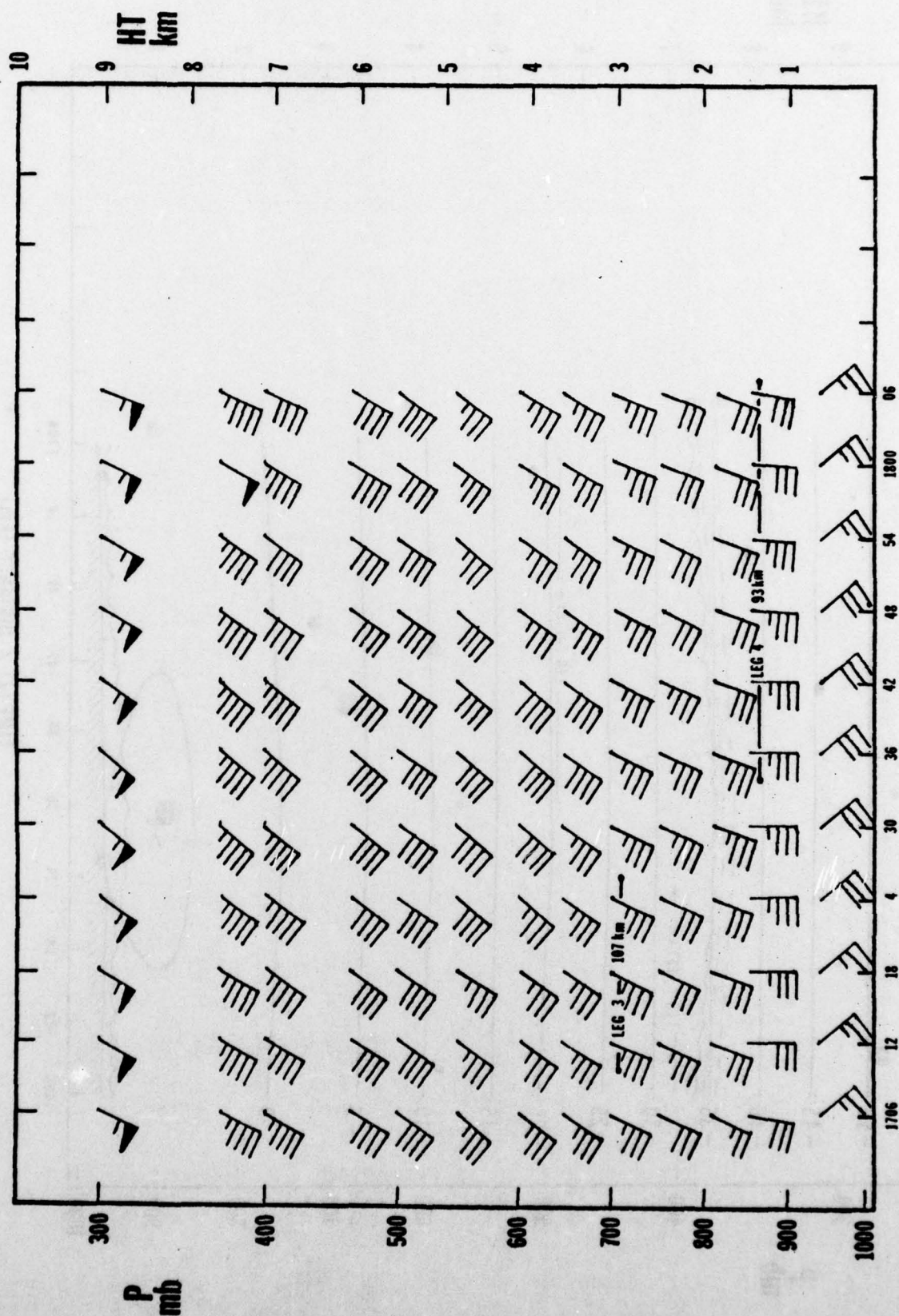


Figure 129. WIND CROSS-SECTION LEGS 3 AND 4 - 26 MAR 78 ANALYSIS

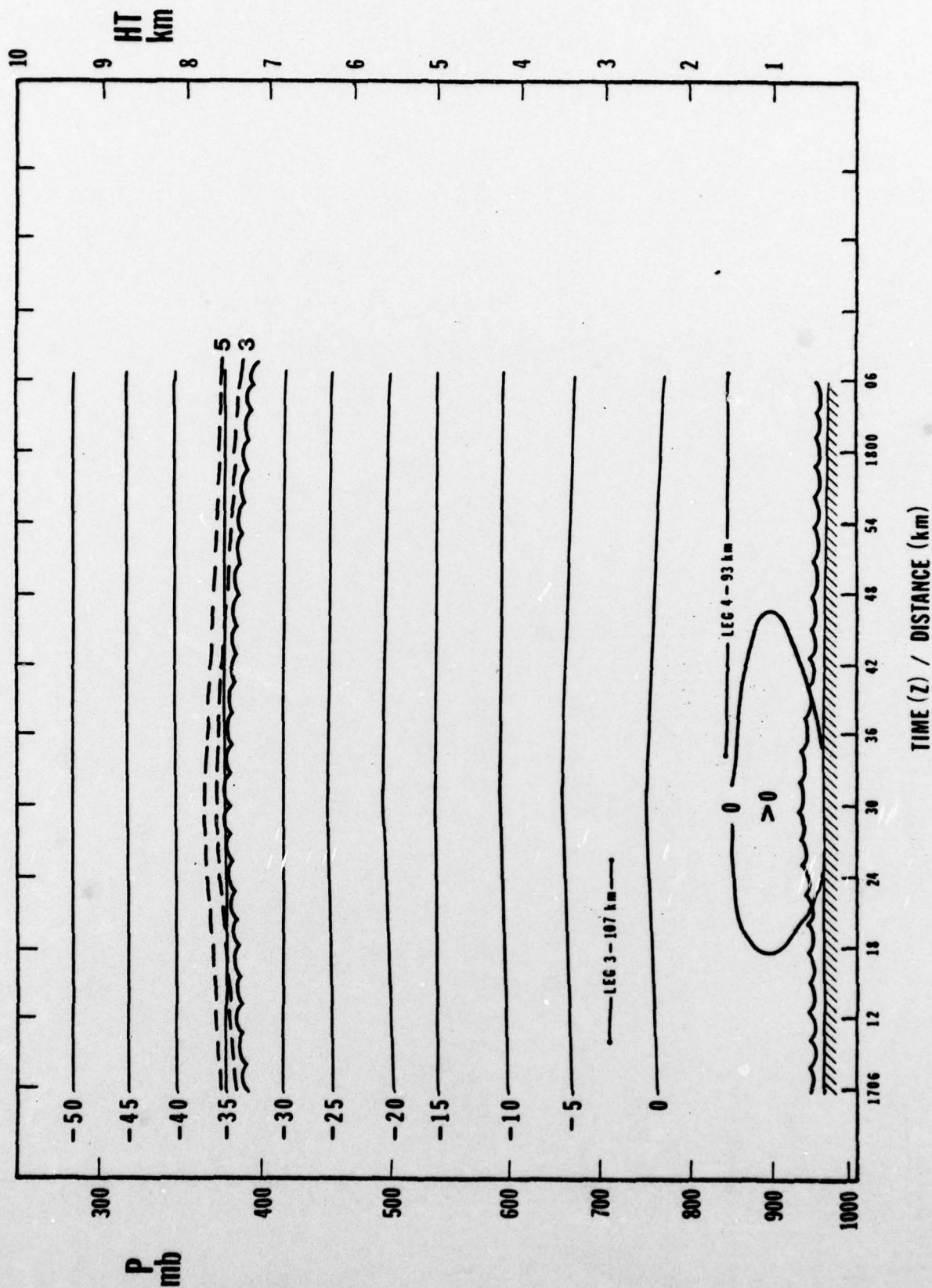


Figure 130. TEMP./DEW PT. DEPRESSION CROSS-SECTION, LEGS 3 AND 4 - 26 MAR 78 ANALYSIS